# PHYSICO-CHEMICAL CONSTANTS
## OF PURE ORGANIC COMPOUNDS

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INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

# PHYSICO-CHEMICAL CONSTANTS OF PURE ORGANIC COMPOUNDS

*by*

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CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE
17 NOV 1950
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ELSEVIER PUBLISHING COMPANY, INC.

NEW YORK AMSTERDAM LONDON BRUSSELS

1950

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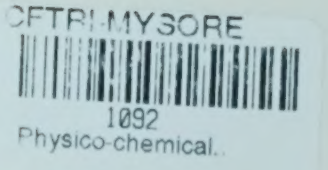


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# PREFACE

The present work is among the fruits of a quarter of a century's activity of the International Bureau of Physico-chemical Standards, and combines the results obtained in their laboratories with those provided by a systematic harvesting of the whole of the chemical literature up to January 1st, 1950. I desire to state that this work could not have been realised without the generous support of the Belgian Chemical Industry and of the Belgian National Fund for Scientific Research.

I take this opportunity of expressing my thanks to those of my collaborators whose publications are quoted in the bibliographical table, and in particular to Mme *Hennaut-Roland*, assistant at the Bureau during a number of years, who has taken a very active part in the experimental work and also in the preparation of the manuscript and the correction of the proofs. I would also like to thank Mr. *Geoffrey Middleton*, B. Sc., F.R.I.C., who undertook the translation of the French text into English and to whom we owe a number of suggestions used in the presentation of this work.

It is inevitable that in such a work there should be errors and omissions; I should be particularly grateful to any of my colleagues if they would inform me of any that they observe.

Brussels, January, 1950

JEAN TIMMERMANS

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Director of the International Bureau of Physico-chemical Standards

# CONTENTS

PREFACE . . . . . v

INTRODUCTION

1. OBJECT OF THE WORK . . . . . 3

2. PHYSICAL PROPERTIES AND CRITERIA OF PURITY

A. Constants of heterogeneous equilibria . . . . . 4
B. Constants of homogeneous phases . . . . . 5
C. Chemical criteria of purity . . . . . 6

3. RULES EMPLOYED TO ASSESS THE ACCURACY AND PRECISION OF THE PUBLISHED VALUES OF CONSTANTS

A. Authenticity of published values . . . . . 7
B. Intrinsic criteria . . . . . 7
C. Criteria of comparison . . . . . 9

4. ARRANGEMENT OF THE TEXT

A. Order of the compounds . . . . . 10
B. Order of subject matter . . . . . 10
C. Numerical values given . . . . . 11
D. Bibliographical references . . . . . 11
E. Bibliographical table . . . . . 11
F. Table of formulae . . . . . 11

5. NOTES CONCERNING SYMBOLS AND UNITS

A. Symbols . . . . . 11
B. Units . . . . . 12

TABLES

1. HYDROCARBONS

A. Paraffins . . . . . 19
B. Ethylenic hydrocarbons . . . . . 115
C. Dienes . . . . . 135
D. Acetylenes . . . . . 138
E. Aromatic hydrocarbons . . . . . 140
F. Polycyclic aromatic hydrocarbons . . . . . 174
G. Condensed polycyclic aromatic hydrocarbons . . . . . 177
H. Polymethylenes . . . . . 183

2. HALOGENATED DERIVATIVES

A. Halogenated derivatives of methane . . . . . 210
B. Halogenated derivatives of ethane . . . . . 231
C. Halogenated derivatives of propane . . . . . 250
D. Halogenated derivatives of butane . . . . . 261
E. Halogenated derivatives of the higher homologous paraffins . . . . 270
F. Halogenated derivatives of unsaturated aliphatic hydrocarbons . . . 276
G. Halogenated derivatives of the aromatic series . . . . . 281
H. Halogenated derivatives of the cycloparaffins . . . . . 301

3. OXYGENATED DERIVATIVES OF THE ALIPHATIC SERIES
A. Alcohols . . . . . 302
B. Ethers and acetals . . . . . 339
C. Aldehydes . . . . . 352
D. Ketones . . . . . 353
E. Oxides . . . . . 365
F. Anhydrides . . . . . 375
G. Fatty acids . . . . . 377
H. Dibasic acids . . . . . 403
I. Unsaturated acids . . . . . 404
J. Esters . . . . . 406

4. OXYGENATED DERIVATIVES OF THE AROMATIC SERIES
A. Alcohols and phenols . . . . . 457
B. Phenol ethers . . . . . 469
C. Aldehydes, quinones, ketones . . . . . 474
D. Acids . . . . . 480
E. Esters . . . . . 482

5. OXYGENATED DERIVATIVES OF POLYMETHYLENES . . . . 489

6. HETEROCYCLIC OXYGEN COMPOUNDS . . . . . 499

7. SUGARS . . . . . 504

8. MIXED OXYHALOGENATED DERIVATIVES . . . . . 506

9. NITROGEN DERIVATIVES OF THE ALIPHATIC SERIES
A. Amines . . . . . 517
B. Hydrocyanic acid; nitriles . . . . . 525

10. NITROGEN DERIVATIVES OF THE CYCLIC SERIES
A. Aromatic amines . . . . . 551
B. Aromatic nitriles . . . . . 566
C. Nitrogen derivatives of the polymethylenes . . . . . 567
D. Heterocyclic derivatives . . . . . 568

11. OXY-NITROGEN DERIVATIVES
A. Aliphatic nitro derivatives . . . . . 577
B. Aliphatic amides . . . . . 582
C. Miscellaneous derivatives . . . . . 588
D. Aromatic nitro derivatives . . . . . 591

12. MIXED HALOGENATED NITROGEN DERIVATIVES . . . . . 602
13. SULPHUR DERIVATIVES. . . . . 610
14. DERIVATIVES WITH OTHER ELEMENTS . . . . . 625
15. ADDENDA . . . . . 628

BIBLIOGRAPHY

1. HISTORICAL . . . . . 631
2. REFERENCES . . . . . 634

INDEXES

1. FORMULA INDEX . . . . . 663
2. SUBJECT INDEX . . . . . 679

# PHYSICO-CHEMICAL CONSTANTS
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# PURE ORGANIC COMPOUNDS

SOLE DISTRIBUTORS FOR THE U.S.A. AND CANADA: ELSEVIER BOOK COMPANY, INC., 215 FOURTH AVENUE, NEW YORK. – FOR THE BRITISH COMMONWEALTH, EXCEPT CANADA: CLEAVER-HUME PRESS, LTD., 42A SOUTH AUDLEY STREET, LONDON, W.I.

# INTRODUCTION

# 1. OBJECT OF THE WORK

This work records, as completely as possible, those physico-chemical constants of organic compounds which have been measured with sufficient care to warrant their acceptance as data established with a precision worthy of contemporary science.

Such a definition excludes at once the great majority of the numerical data which have accumulated during a century. Among some tens of thousands of compounds, the majority have been examined from a chemical point of view only (method of preparation and reactivity) and the samples used can not be considered as very pure. Only a few thousands of compounds of particular interest have been the subject of numerous and careful determinations; an enormous number must be rejected because so few measurements are satisfactory, both with regard to the purity of the sample and the accuracy of the method of physical measurement which has been used. The difficulties to be overcome will be better understood after a study of the book written by J. TIMMERMANS: "*La Notion d'Espèce en Chimie*" (Paris, Gauthier-Villars, 1928), which, according to HILL [1], contains the most complete and systematic codification of the precautions which must be taken in order that a constant may acquire the character of a real physico-chemical standard [2].

We will sum up these factors by stating that the sample examined must be of a sufficient purity, and the method of measurement of such a degree of sensitiveness and precision that, thanks to a harmonious equilibrium between the different sources of error, one may be sure of the penultimate decimal given; the uncertainty resting only with the last figure.

Accordingly, we intend to include in the present publication only those values of physico-chemical constants of organic compounds which have positive guarantees of precision; we have therefore rejected, not only the results of obviously inaccurate work, but also the innumerable publications which do not give any details to allow of an appreciation of the precision; among those results some are possibly accurate and may even be of considerable interest from other points of view, but they can not be considered as established with a sufficient degree of certainty to be accepted as true standards. For the same reason, it is in exceptional cases only that we have studied the compounds for which only one author has determined the usual constants of organic chemistry (boiling and melting point, density and refractive index at one temperature only), and the compounds for which the heat of combustion forms the sole object of the research.

[1] *J. Am. Chem. Soc.*, 50 (1928) 2847.

[2] This work has been brought up to date and translated by Prof. RALPH E. OESPER under the title of "*Chemical Species*". New York and London, 1940—1941.

## 2. PHYSICAL PROPERTIES AND CRITERIA OF PURITY

We enumerate briefly below the chief criteria of purity currently used in organic chemistry, the systematic application of which has forced us to reject the great majority of published results. The constants normally determined with sufficient accuracy may be classified under three headings.

### A. CONSTANTS OF HETEROGENEOUS EQUILIBRIA

a) At a given pressure, a pure substance has a constant *boiling point*, invariable from the beginning to the end of the distillation. We have rejected all samples for which the boiling range exceeds one tenth of a degree; for commercial substances, where large quantities of material are available, we have moreover only considered samples distilling within the limits of some hundredths of a degree. The use of SWIETOSLAWSKI's ebulliometer will make it possible in the future to check the constancy of the boiling point of a sample to nearly one thousandth of a degree. (See the investigations of the collaborators of SWIETOSLAWSKI [1] and of GILLO [2]).

The *boiling point* should be known to about 0.05°, with regard to its absolute value; the work of recent years has brought new complications in the choice of the scale of reference (on this question, see p. 14).

b) The *saturated vapour pressure* of a pure substance remains strictly constant during the whole range of isothermal liquefaction (S. YOUNG) [3]. We have rejected samples for which the pressure changed by more than one five-hundredth of its value from the beginning to the end of the isothermal liquefaction or vaporization. The pressure of the saturated vapour is very sensitive to the presence of dissolved gas, which causes the values to be too high; as for the influence of temperature, the whole curve may be checked by using a graph of log P against $1/T^\circ$; divergences greater than 1 % should not be accepted.

c) The *critical temperature and pressure* are very sensitive to the presence of impurities; only contemporary values are concordant to ± 0.05° (work of the Dutch physico-chemical school, measurements made by YOUNG, CARDOSO and the American investigators).

The critical volume and density can hardly be determined to about 0.001 except indirectly by using the rule of the rectilinear diameter.

The *critical constants* are extremely sensitive criteria of purity both as absolute values and also owing to the considerable variations which they undergo in the course of systematic fractionation of an impure sample; this criterion of purity

[1] W. SWIETOSLAWSKI, *Ebulliometric Measurements*, New York, 1945.
[2] L. GILLO, *Bull. soc. chim. Belg.*, 48 (1939) 341.
[3] S. YOUNG, *J. chim. phys.*, 14 (1906) 434.

plays a very important part in the study of substances which are gaseous at ordinary temperature.

The *critical solution point* (t°.cr.s.) in a suitable solvent, is also a criterion of purity which is often useful in the study of organic liquids (Crismer index).

d) The *freezing or melting point* is a very useful criterion of homogeneity. When the freezing range is greater than one tenth of a degree, we have considered the sample as impure. During recent years, the National Bureau of Standards of Washington has brought into use a method of determination of the exact amount of impurities in a sample (up to 1 in 100,000) from a study of the complete freezing curve measured to 0.0001° [1].

The absolute value of the freezing point should be known to about 0.1°. The variation of the melting point as a function of high pressure has been determined with sufficient accuracy by BRIDGMAN and DEFFET only.

## B. CONSTANTS OF HOMOGENEOUS PHASES

a) The *constants of state* (with their temperature coefficients) give numerical characteristics of the various physical states of each substance (vapour, liquid, crystal).

The *specific weight* referred to its value in vacuo, should be known to within at least 0.02 %.

The absolute values of the *viscosity* are difficult to measure with an accuracy greater than 1 % (too high values recorded in the literature are often due to turbulent flow).

The *surface tension* is difficult to measure with an accuracy greater than about 0.2 %. (HARKINS alone has succeeded in measuring surface tension by methods other than that of capillary rise).

The *refractive index* for different wavelengths can hardly be determined at present with an accuracy greater than the fourth decimal. We may hope for better agreement when the method of comparative measurement elaborated by SMITH is in general use.

The *dielectric constant* is rarely known within less than about 0.1 %.

The *specific rotatory power* and the *magnetic susceptibility* of pure organic compounds have been determined with accuracy in a very small number of cases; only PERKIN has measured the *magnetic rotatory power*, giving at the same time sufficient details to allow of an appreciation of the accuracy attained.

The majority of these constants have been determined, without ambiguity and with sufficient precision, for the liquid state only. For most gases, measurements of refractive index, dielectric constant and specific heat have been carried

[1] A. R. GLASGOW Jr., J. STREIFF and F. D. ROSSINI, *J. Research Nat. Bur. Standards*, 35 (1945) 355. F. W. SCHWAB and E. WICKERS, *J. Research Nat. Bur. Standards*, 34 (1945) 333.

out by physicists on samples of which the purity cannot be estimated and by using methods whose results are not very concordant; only the studies of the weight of the normal litre, of the coefficients of compressibility and expansion, and of isothermals, have given entirely satisfactory results.

In the vitreous or crystalline state, most of the constants have been determined on poorly defined samples from which the dissolved gas had not been carefully expelled; only very few of these densities can be accepted (on this subject see the very pertinent remarks of E. COHEN) [1].

The invariability of suitable constants of state, confirmed on different portions of a sample which has been submitted to systematic fractionation, has often been used as a criterion of purity.

b) The *heat constants* (specific heat, latent heat of transformation, heat of combustion).

The *mean specific heat* between two temperatures has been rejected; only contemporary measurements in which the specific heat has been determined for each temperature have been retained (results of the American school); in this case especially the physical state of the samples (liquid, glass, polymorphous forms) should be carefully defined.

Except in a few special cases, the specific heat of the crystalline phase is lower than that of the corresponding liquid phase; if the specific heat of the crystals rises rapidly when approaching the melting point, the sample may generally be considered as impure; but this criterion of purity is so sensitive that up to the present it has always been at fault when the measurements were sufficiently near the melting point (see E. L. SKAU) [2].

Note that too high a value for the specific heat of the crystals corresponds to too low a value for the latent heat of fusion.

The heat of combustion has been expressed, as far as possible, in calories at 15° per gram of substance weighed in vacuo; only the results of the last twenty years have been retained, because they alone have been determined by comparison with the international calorimetric standard: the benzoic acid of the National Bureau of Standards of Washington.

## C. CHEMICAL CRITERIA OF PURITY

In former days, many chemical reactions were used to reveal the presence of impurities in organic compounds, but it must be recognized that the sensitiveness and specificity of these reactions are generally insufficient. It is however possible to improve some of these methods so as to demonstrate the presence of such small

[1] E. COHEN, *Z. physik. Chem.*, 150 A (1930) 418. (Regarding chemical and physical purity).
[2] E. L. SKAU, *Bull. soc. chim. Belg.*, 43 (1934) 287.

traces of impurities that they have no influence on the values of physical constants measured with the usual accuracy (see the researches of GILLO).

## 3. RULES EMPLOYED TO ASSESS THE ACCURACY AND PRECISION OF THE PUBLISHED VALUES OF CONSTANTS

These rules refer to three different sets of considerations.

### A. AUTHENTICITY OF PUBLISHED VALUES

When consulting a treatise of historical criticism, one realizes that the largest part of the work concerns the degree of authenticity of the written sources of information, which are often transmitted in a form very different from that of the original text. This question practically never arises for us, since the publications, of which we discuss the contents, are accessible as works printed under the direct control of the author. The only important point, in this respect, is the existence of misprints, unnoticed by the proof reader, and of errors or omissions due to faulty editing of the original paper. For example: RICHARDS and MATHEWS, in a paper concerning surface tensions at 30°, give values of the density at 20°; a comparison of their values with those of other authors shows that the measurements of density have very probably been made at 30° like those of surface tension quoted in the next column of their table of experimental results.

On the other hand, the exactness of many measurements of temperature, for instance, cannot always be estimated with accuracy, because the author does not indicate whether or not he has applied the necessary correction for the emergent column; and again for densities, because he does not state whether or not he is giving values reduced to vacuo, values at t°/t° or at t°/4°, and so on.

### B. INTRINSIC CRITERIA

These criteria permit of a direct appreciation of the value of the work in itself. They result from the considerations given in paragraph 2 concerning the purity of the samples, combined with an appreciation of the precision of the physical methods used by the author.

a) If the *origin of the samples* or their *method of purification* does not assure the purity of the compound, all the constants given for that sample are evidently of little value. This is the case, for instance, with the saturated hydrocarbons of the fatty series prepared by simple fractionation of mineral oils. Only S. YOUNG, later CHAVANNE in Brussels and WASHBURN in Washington, have succeeded in preparing pure pentane and hexane in this way, but the fractionation took several months of work. Subsequently, the National Bureau of Standards of Washington,

in collaboration with the American Petroleum Institute, has perfected these methods so as to make them less tedious. Similarly, chloroform gives exact physical constants only if it is examined immediately after distillation over phosphorus pentoxide: simple fractionation of the medicinal product gives merely the azeotrope with alcohol, and when this stabiliser is removed the chloroform in contact with air, oxidises rapidly.

b) When the value of one of the principal constants indicates that a sample is impure, all other constants of the same sample must be rejected.

This happens, for example, when the samples do not distil at constant temperature or when their density is notoriously inaccurate. In fact, one may well believe that an author who is unable to measure exactly the density —a relatively simple operation—is not likely to show any aptitude in overcoming much greater difficulties in the measurement of, for example, a dielectric constant. Conversely, if his determination of density is accurate, the impurity of the sample is proved beyond doubt.

c) But inaccurate figures for some of the constants of a sample of a pure compound do not always necessitate the rejection of the other constants given for the same sample. Anomalies of this kind occur if the calibration of an instrument has been done by means of inaccurate standards—e.g., the thermometric scale above 100° accepted by KAHLBAUM of Basle and his pupils is definitely too low —or if the author has neglected a correction which is indispensable if the desired degree of precision is to be attained—e.g., the correction for turbulence in the measurement of viscosity performed with capillaries of too great a diameter; for this reason, all such results of KASSEL and SCHEUER are too high.

d) It is possible to judge the accuracy of certain numerical data, which are not directly comparable with each other, by referring them to similar conditions by means of suitable formulae or diagrams. Thus, at temperatures appreciably below the boiling point at normal pressure, the variation of the density of a liquid is linear, within about 0.01 %, for an interval of 20 to 30 degrees. It is precisely in order to permit of the comparison of measurements, executed at different temperatures, that we make a point, at the International Bureau of Standards of Brussels, of determining the temperature coefficients of these constants.

e) Further, one can detect immediately the erratic behaviour of certain groups of results by means of suitable graphs; such are: the dispersion, by plotting the refractive index as a function of the inverse square of the wavelength; or the curve of saturated vapour pressure, with the logarithms of the pressure as ordinates and the inverse of the absolute temperatures as abscissae.

## C. CRITERIA OF COMPARISON

Here the results of measurements of the same constant, carried out by different authors, are compared.

a) The *concordance of the values* given by several authors, observed on samples of diverse origin and with different apparatus, is generally an evidence of correctness, for truth alone is unique, while error is manifold. But one ought to make sure that these concordant results have not been determined on the same sample of substance which has passed from hand to hand; or again that the new data are not just a copy of results published previously. Thus the samples of *iso*amyl compounds which were used in the investigations of LANDOLT and of his collaborators on the dielectric constant and the magnetic rotatory power were all the same; accordingly the absolute agreement of densities given by this series of investigators cannot be considered as a confirmation of their exactness.

b) The personality of the author also plays a part; has he generally shown evidence of a critical outlook in the choice of the method of purification of his samples and in the evaluation of the degree of precision of his physical methods? One should not fear too much modesty on this point; COLLARDEAU [1] has shown that REGNAULT himself enormously exaggerated the precision of his determinations of coefficients of expansion of gases.

With regard, for instance, to surface tension, all the measurements of some laboratories, executed by the stalagmometric method, are tainted with systematic errors.

c) The measurements of a specialist are of infinitely more weight than those of a newcomer or of one of those observers who have acquired the unfortunate reputation of filling the periodicals with premature publications. Again an author, who is well known for his researches on viscosity, would not indeed appear to be worthy of any confidence, when it is found that he is generally in disagreement with other specialists such as THORPE, and further, when he gives, and without mentioning the divergence to the reader, such different values for the viscosity of benzene at 25° as:

$$\eta \cdot 10^5 = 582 \text{ (1904)}, 598 \text{ (1905) and } 614 \text{ (1908)}.$$

d) At the same time the results of systematic research on a particular constant are much preferable to values determined incidentally during the course of work on a different object; in his fine papers, WALDEN gives the freezing point below 0° of a large number of organic compounds; in spite of the well-deserved reputation of their author, these values do not offer any guarantee, because he has evidently used an inaccurate scale of temperature, neglecting the correction for the emergent

[1] E. COLLARDEAU, *Les approximations dans les mesures physiques*. 1 Vol. 8vo. Paris, 1906.

stem of his thermometer, so that his freezing points below the ice point are much too high. It should be noted here that if the freezing point to be measured is below 0°, this correction is negative and consequently the freezing point given by the author will be much too high and, in distinction to the usual case, here the best melting points are the lowest and not the highest ones.

e) Finally, all other considerations being put aside, the most recent work is more likely to be the best: results prior to 1900 are rarely useful except when they derive from classical authors such as PERKIN, YOUNG, THORPE, BRÜHL, etc. It is necessary however to make sure that the contemporary author is up to date with the subject, since, in the domain of pure compounds, results proving an inconceivable ignorance of previous work are published every day; many authors, including RAMSAY in 1910, have used sodium for dehydrating ethyl alcohol, and lime for methyl alcohol, although it had been shown by CRISMER in 1907, by means of the critical solution temperature test, that in both these cases an equilibrium was established between alcoholate and hydrate and that therefore the dehydration of alcohol was incomplete by such methods.

## 4. ARRANGEMENT OF THE TEXT

### A. ORDER OF THE COMPOUNDS

The substances are arranged according to their composition and their chemical function; first all the acyclic hydrocarbons, saturated and unsaturated; then the aromatic hydrocarbons and the polymethylenes (*cyclo*paraffins); further on, the halogenated derivatives in the same order; the oxygenated derivatives (alcohols and ethers, aldehydes and ketones, acids and esters), the nitrogen compounds (amines, nitriles, nitro derivatives, amides, etc.), mixed compounds (oxyhalogenated, nitrohalogenated compounds, etc.), and finally sulphur and phosphorus derivatives, etc.

In each group, the compounds of the aliphatic series come first, then those of the aromatic and polymethylene series with heterocyclic derivatives at the end. For some compounds where comparative data are scarce, we merely refer to the literature (small text).

### B. ORDER OF SUBJECT MATTER

For each compound, general considerations on the method of purification are followed by criteria of purity and bibliographical sources. We note always whether the compound has been the subject of a publication by the International Bureau of Standards of Brussels. The constants studied are always placed in the same order: constants of heterogeneous equilibrium, then constants in the vapour, the liquid and the crystalline state, and finally heat constants.

### C. NUMERICAL VALUES GIVEN

For each constant, there are given all the values which have not been eliminated by using our intrinsic criteria and which do not differ too much from the most probable values given by recognised specialists. When reliable comparative data are lacking, figures showing a sufficient degree of agreement are retained; this however is somewhat rare.

One will not be surprised to see frequently quoted the data of the International Bureau of Standards (B.E., for Bureau d'Etalons) of Brussels, as that laboratory has specialised in that kind of work for twenty-five years, but there has been no hesitation in rejecting the data of this laboratory when later work has shown its inaccuracy.

### D. BIBLIOGRAPHICAL REFERENCES

The origin of the numerical data in the text is shown by bibliographical references with the name of the author and the date of publication. These refer to the bibliography at the end of the work.

### E. BIBLIOGRAPHICAL TABLE

This table gives all the original works quoted in the text in the alphabetical order of the authors and the seniority of their publications; it contains some notes on the value of such and such particular work, and is prefaced by a short historical review of the subject.

### F. TABLE OF FORMULAE

This table contains the empirical formulae and the names of all the substances measured, classified according to the order adopted in the tables of *Chemical Abstracts*, published by the American Chemical Society.

## 5. NOTES CONCERNING SYMBOLS AND UNITS

### A. SYMBOLS

The chemical compounds are represented by their formulae and their names; these are also given in the table of formulae at the end of the book.

Below, the symbols which are used in this work are listed. Their choice is derived from the conclusions of the International Commission for the Unification of Physico-chemical Symbols (*Z. Electrochem.*, 27 (1921) 527), and as far as possible it takes into account the recommendations of the "Report on Symbols for Thermodynamic and Physico-chemical Quantities, and Conventions Relating to their Use" (*Trans. Chem. Soc.*, (1937) 2091) which has recently been amended by the XIVth Conference of the International Union of Chemistry (London, July, 1947).

*Physical constants*

| | | | |
|---|---|---|---|
| Degrees (Centigrade) | t° | Atmospheres | atm |
| Degrees (Kelvin) | T° | Kilogram/cm² | kg/cm² |
| Pressure | p | C.G.S. units | C.G.S. |
| Millimetres of mercury | mm | | |

*Polyphasic equilibria*

| | | | |
|---|---|---|---|
| Liquid | L. | Saturated vapour pressure | $p_v$ |
| Gas | G. | Melting or freezing point | M.P. |
| Vapour | V. | Transition point | Tr. P. |
| Solid | S. | Boiling point | B.P. |
| Crystal | C. | Critical point | t°cr |
| Critical constants | cr. | Critical solution point | t° cr. s. |

*Heat constants*

| | |
|---|---|
| Calorie | cal |
| Specific heat or heat of combustion at constant volume | $c_v$ |
| Specific heat or heat of combustion at constant pressure | $c_p$ |

*Constants of state*

| | | | |
|---|---|---|---|
| Density | d | Dielectric constant | $\varepsilon$ |
| Viscosity | $\eta$ | Rotatory power | $\alpha$ |
| Surface tension | $\gamma$ | Magnetic susceptibility | $\chi$ |
| Refractive index | n | „ rotatory power | $\mu$ |

## B. UNITS

In order to facilitate the use of this work we have been careful to reduce the results of different authors to the same system of units, where this has appeared to be useful; below will be found some comments on this subject.

### a) 0° *of the centrigrade scale of temperature*

The temperatures are expressed sometimes in Centigrade degrees (t°), sometimes in absolute degrees (T°). Unfortunately, a factor of uncertainty about the correspondence of these two scales results from the disagreement which has existed for a long time with regard to the exact value of the zero point of the Centigrade scale on the absolute scale. German publications generally accept the value $0° \text{ t} = 273.18° \text{ T}$ of the Physikalisch-Technische Reichsanstalt of Charlottenburg, recognised by German law (see L. Holborn, K. Scheel, and F. Henning, *Wärmetabellen*, 1919, p. 7). The Dutch school uses the scale of the Cryogenic Laboratory at Leyden, on which the zero point is at 273.12° T. The American school, on the contrary, makes use of the scale of the National Bureau of Standards:

$0° t = 273.16° T$. It is necessary to take into account these differences when comparing results of authors from different countries; fortunately subsequent researches have led to agreement on an intermediate value of 273.15° T. (Report of the 7th International Congress on Cold, The Hague, 1937, and Decisions of the 8th Conference of the International Bureau of Weights and Measures at Sèvres, in October 1948: $0° t = 273.15° T$).

b) *International Scale of Temperature*

Thanks to the initiative of the International Bureau of Weights and Measures of Sèvres [1], the chief laboratories interested in that matter have agreed on an empirical and provisional definition of the International Scale of Temperature. This scale is defined from two different points of view: by adoption of some fixed points of reference and by interpolation formulae for the intermediate regions, with the aid of the platinum resistance thermometer. In addition, some secondary fixed points have been accepted; their value is given below so far as they are useful for us.

*Fundamental fixed points of the International Scale of Temperature*

1) Temperature of equilibrium between liquid and gaseous oxygen at a pressure of a standard atmosphere (boiling point of oxygen: −182.97°)

$$t_p = t_{760} + \frac{21.94 \lg \frac{p}{p_0}}{1 - 0.261 \lg \frac{p}{p_0}}$$

2) Temperature of equilibrium between ice and water, saturated with air, at a pressure of a standard atmosphere (melting point of ice: 0°). This temperature is at present defined as being 0.0100° lower than the triple point of water.

3) Temperature of equilibrium between liquid water and its vapour at a pressure of a standard atmosphere (boiling point of water: 100°)

$$t_p = t_{760} + \frac{64{,}5 \lg \frac{p}{p_0}}{1 - 0.1979 \lg \frac{p}{p_0}}$$

4) Temperature of equilibrium between liquid sulphur and its vapour at a pressure of a standard atmosphere (boiling point of sulphur: 444.60°)

$$t_p = t_{760} + \frac{158.92 \lg \frac{p}{p_0}}{1 - 0.234 \lg \frac{p}{p_0}}$$

c) *Secondary fixed points at low temperatures*

This agreement will doubtless lead in the future to greater homogeneity between the results of authors of different countries, but for those which are already recorded in the literature, there are certain peculiarities to which attention should

[1] *Comptes Rendus, 9th Conference* Paris (1948) 32—49.

be drawn: side by side with some very recent measurements in which use has been made of the International Scale defined as above, the majority of the values for temperature given in this work, are based on a series of standard points, which were used for the calibration of the thermometers and which do not always agree exactly with the values deduced from the above International Scale; the differences are, however, in general negligible.

*Temperatures below 0°*: the numerous results of TIMMERMANS are reported on a scale determined by the following fixed points:

| Substance | Old scale (1912) | Corrected scale (1922) | Scale of the National Bureau of Standards (1947) |
|---|---|---|---|
| $CCl_4$ | −22.95 | −22.85 | — |
| $C_2H_5Cl$ | −45.0 | −45.2 | — |
| $CHCl_3$ | −63.3 | −63.4 | — |
| $CH_3CO_2C_2H_5$ | −83.4 | −83.6 | — |
| $C_6H_5CH_3$ | −94.5 (*) | −95.1 | −94.991 |
| $CS_2$ | −111.6 | −111.85 | — |
| $C_2H_5OC_2H_5$ (a) | −116.2 | −116.3 | — |
| (b) | −123.3 | −123.3 | — |
| $C_6H_{11}CH_3$ | −126.4 | −126.35 | −126.57 |
| $C_5H_{12}$ *iso* | −158.05 (*) | −160.0 | −159.890 |

N.B. There is no important difference except for toluene and *iso*pentane. The measurements of TIMMERMANS *et al.*, using the hydrogen thermometer scale of the cryogenic laboratory at Leyden [1], and the determinations of SKAU (*J. Phys. Chem.*, 37 (1933) 609) which were made on a thermocouple scale, give slightly different values. In order to avoid any confusion, all the results of TIMMERMANS have been expressed on his old scale, without later corrections.

d) *Secondary standards above 0°*

Between 0° and 160° other difficulties appear (see Annexe II of the Report of the International Bureau of Physico-chemical Standards for the period 1936—1937, presented to the XIIth Conference of the International Union of Chemistry at Rome in May 1938).

At the International Bureau of Physico-chemical Standards, the secondary standards, which we used, are the boiling points of pure organic substances which were determined with the greatest care by RAMSAY and YOUNG on the air thermometer scale some 50 years ago; until now the values adopted were considered as exact and reproducible to about 0.05, and were the standards generally adopted.

[1] J. TIMMERMANS, *Communications, Leyden*, Supplements 51b (1924), 64a (1928). J. TIMMERMANS, H. VAN DER HORST and H. KAMERLINGH ONNES, *Compt. rend.*, 174 (1927) 368; *Arch. Neerl.* III A, 6 (1922) 1180 and *Communications, Leyden*, No. 157 (1922).

During recent years, ZMACZYNSKI, WOJCIECHOWSKI, BYLEWSKI, SWIETOSLAWSKI, on the one hand, and a number of American scientists working at the National Bureau of Standards on the other (MAIR, BRUUN, SMITH, and MATHESON) have moreover measured the boiling point of the same compounds, using the resistance thermometer, and samples of the compounds which had been carefully purified and of which the constants (density and refractive index) coincided with those of the samples of the "International Bureau of Standards"; in certain cases, the authors even used samples provided by our laboratory. Generally, the values found by these authors for the boiling points are slightly lower than those which we have adopted. In the most unfavourable case (normal butyl alcohol) the divergence is as much as 0.28°.

*The following table summarizes these observations*

| | S. YOUNG | | Nat. Bur. Stand. | | SWIETOSLAWSKI | |
|---|---|---|---|---|---|---|
| Compounds | t° | $\frac{dt}{dp}$ | t° | $\frac{dt}{dp}$ | t° | $\frac{dt}{dp}$ |
| $C_5H_{12}$ | 27.95 | 0.37 | 27.854 | 0.381 | — | — |
| $C_2H_5Br$ | 38.40 | 0.36 | — | — | 38.402 | — |
| $CS_2$ | 46.25 | 0.42 | — | — | 46.270 | — |
| $CHCl_3$ | 61.20 | 0.38 | — | — | — | — |
| $CCl_4$ | 76.75 | 0.44 | — | — | 76.786 | — |
| $C_6H_6$ | 80.20 | 0.43 | 80.101 | 0.427 | 80.110 | — |
| $H_2O$ | 100.00 | 0.37 | 100.00 | 0.367 | 100.00 | 0.3666 |
| $C_6H_5CH_3$ | 110.80 | 0.42 | 110.625 | 0.463 | (110.615) | — |
| $C_6H_5Cl$ | 132.00 | 0.49 | — | — | 131.842 | — |
| $C_6H_5Br$ | 156.15 | 0.53 | — | — | 156.010 | — |
| $C_6H_5NH_2$ | 184.40 | 0.51 | — | — | — | — |
| $C_6H_5NO_2$ | 210.85 | 0.48 | — | — | — | — |
| $C_{10}H_8$ | 218.00 | 0.58 | — | — | — | — |

S. YOUNG (1910); B.J. MAIR(1932); M. WOJCIECHOWSKI (1936—37); M. WOJCIECHOWSKI and E. SMITH (1937); A. ZMACZINSKI (1930—36); W. SWIETOSLAWSKI (1934); T. BYLEWSKI (1932); M. M. HICKS-BRUUN and J. H. BRUUN (1932); E. R. SMITH and H. MATHESON (1938). N.B. The value in parentheses is less certain than the others.

e) *Calorific values*

These values are always expressed in cal (usually cal 15°): the heats of combustion expressed in joules by the National Bureau of Standards have been converted to calories by using as conversion factor:

1 International Joule = 1.00032 absolute joules

1 cal 15° = 4.185 absolute joules

See National Bureau of Standards (1947).

The heats of combustion, expressed at constant volume or pressure per g of substance weighed in vacuo, have only been retained from measurements performed after 1921, since benzoic acid was only adopted as thermochemical standard at the IIIrd Meeting of the International Union of Chemistry at Lyons in 1922. The values given by the IVth and the XIIth Conferences (1922—1928) for the heat of combustion of pure benzoic acid are as follows:

| | | | |
|---|---|---|---|
| 0° | 6323.3 cal 15° | 18° | 6319.4 cal 15° |
| 15° | 6320.1 „ | 19° | 6319.2 „ |
| 16° | 6319.9 „ | 20° | 6319.0 „ |
| 17° | 6319.6 „ | 21° | 6318.8 „ |

In addition, the XIIIth Conference (Zürich 1936) adopted as secondary thermochemical standard succinic acid, for which the heat of isothermal combustion at 20° is 3025.5 cal 15°.

Roth and Lamprecht (1938) have made a further revision of the heats of combustion of benzoic and succinic acids, but their agreement with the standard value is not perfect.

f) *Other units*

Viscosity ($\eta$): the centipoise represents $10^{-2}$ C. G. S. units.

Surface tension ($\gamma$): always expressed in dynes per $cm^2$.

Rotatory power and magnetic susceptibility expressed in specific units, *i.e.* per g of substance.

Heat constants are always specific and not molecular values; in case of reduction of the second one to the first, we have used, so far as possible, the molecular weights given by the authors themselves (value in brackets); or else we accept the following values of the atomic weights:

| | | | |
|---|---|---|---|
| C | 12.000 | F | 19.000 |
| H | 1.0078 | Cl | 35.456 |
| O | 16.000 | Br | 79.92 |
| S | 32.06 | I | 126.92 |
| N | 14.008 | P | 31.04 |

In the Project No. 44 of the Researches sponsored by the American Petroleum Institute, and carried out at the National Bureau of Standards at Washington, tables of spectra of hydrocarbons (Raman, infra-red, ultra-violet, and mass spectra) are collected. These tables have not been reproduced in the present work.

# TABLES

# 1. HYDROCARBONS

The hydrocarbons and in particular the paraffins and benzene are a first rate physico-chemical material. Accordingly, their constants have been the subject of a very great number of determinations; nevertheless, many of their physical constants are not yet known with the accuracy desirable.

## A. PARAFFINS

### METHANE $CH_4$

*Bibliography*: Malisoff and Egloff (1918)

It is rather amazing to find that the exact values of the physical constants of methane have not yet been determined. In fact, very few results can be accepted as data worthy of contemporary science; this is due, on the one hand, to the impurity of the gas yielded by old methods of preparation and, on the other hand, to the uncertainty of the low temperature scale used in many cases.

*Preparation of methane in the pure state*: Baume and Perrot (1909)

Six methods have been used for the preparation of methane:

1°) Calcination of a mixture of sodium acetate and sodium hydroxide.
2°) Decomposition by water of organo-magnesium compounds formed from methyl halides.
3°) Action of zinc-copper couple on methyl iodide.
4°) Action of methyl iodide on sodium ammonium.
5°) Decomposition of aluminium carbide by water.
6°) Action of metallic sodium on acetonitrile.

The first, second and third methods produce methane with impurities whose complete elimination is very difficult (ethane, ethylene, acetone, etc.). The fourth and fifth methods produce methane which is easier to purify (water vapour, ammonia, etc.). Only the sixth method gives directly a very pure gas.

Moreover, air is very soluble in liquid methane and escapes during freezing; and is therefore easy to eliminate completely. In any case, the purification must be completed by very narrow fractional distillations.

The best criteria of purity are the constancy of the saturated vapour pressure during the isothermal liquefaction, the constancy of the freezing point along the freezing curve and, finally, the value of the critical constants. At present, industry produces methane which is approximately pure.

**Constants. — Polyphasic equilibria**

*Critical constants:* Survey by PICKERING (1924) — t. cr: Still not known with a sufficient degree of accuracy; the gas used by CARDOSO (1913—15) was very pure but unfortunately his thermometric scale was unreliable in that temperature region.

| p cr.atm. | d cr. | |
|---|---|---|
| 45.60 | 0.1623 | CARDOSO (1913—15) |

*Saturated vapour pressure:* the values given by CARDOSO are unreliable owing to his temperature scale; the best values have been obtained by HENNING and STOCK (1921) or STOCK, HENNING and KUSZ (1921)

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −161.37 | 760 | −173.49 | 249.4 | HENNING and STOCK (1921) |
| −162.45 | 691.1 | −181.87 | 94.2 | „ |
| −164.77 | 570.9 | −186.67 | 46.7 C. | „ |
| −170.49 | 536.6 | −192.89 | 16.0 C. | „ |

| | | |
|---|---|---|
| *Triple point* (p mm) | 87.4 | FRANK and CLUSIUS (1937) |
| | 87.5 | CLUSIUS and POPP (1940) |
| | 87.75 | STAVELEY and GUPTA (1949) |
| *Melting point* | −182°49 | CLUSIUS (1929) and CLUSIUS and WEIGAND (1940) |
| | −182°52 | CLUSIUS and POPP (1940) |
| *Transition point* | −252°66 | CLUSIUS (1929) and CLUSIUS and WEIGAND (1940) |
| | −252°74 | CLUSIUS and POPP (1940) |

*Melting curve:* CLUSIUS and WEIGAND (1940)

| t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|
| −178.53 | 155.6 | −180.01 | 96.2 | −181.22 | 48.3 |
| −178.78 | 145.8 | −180.25 | 86.8 | −181.46 | 39.0 |
| −179.02 | 136.25 | −180.50 | 77.1 | −181.75 | 28.8 |
| −179.28 | 126.3 | −180.75 | 67.2 | −181.95 | 20.7 |
| −179.54 | 115.3 | −180.98 | 58.2 | −182.23 | 9.5 |
| −179.16 | 106.9 | −180.98 | 58.0 | −182.49 | 0.115 (87.4 mm) |

*Weight of the normal litre in the gaseous state:* 0.7165 g BAUME and PERROT (1909)

*Isotherms*

KEYES and BURKS, (1927) (between 0° and 200° and from 30 to 250 atm.)
KVALNES and GADDY, (1931) (between −70° and +200° and from 1 to 1000 atm.)
MICHELS and NEDERBRAGT, (1935—36) (between 0° and 150° and until 80 atm.)

## Heat constants

*Specific heat:* CLUSIUS (1929) and CLUSIUS and PERLICK (1934)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. I −262.77 | 0.05951 | −254.28 | 0.3196 | −214.8 | 0.5284 |
| −262.32 | 0.06606 | −253.95 | 0.3613 | −211.7 | 0.5410 |
| −262.12 | 0.06974 | −253.43 | 0.4474 | −208.0 | 0.5498 |
| −261.75 | 0.07261 | −253.17 | 0.5374 | −205.9 | 0.5583 |
| −261.12 | 0.08003 | −252.89 | 0.8303 | −204.5 | 0.5634 |
| −261.04 | 0.08602 | −252.62 | 2.5263 | −202.4 | 0.5724 |
| −260.77 | 0.08820 | −252.62 | 3.0403 | −201.2 | 0.5771 |
| −260.02 | 0.1072 | C. II −252.24 | 0.7529 | −198.1 | 0.5852 |
| −259.91 | 0.1156 | −252.16 | 0.6224 | −197.5 | 0.5926 |
| −259.62 | 0.1180 | −250.30 | 0.2881 | −193.7 | 0.6026 |
| −258.92 | 0.1275 | −248.2 | 0.3076 | −193.6 | 0.6060 |
| −258.65 | 0.1380 | −246.4 | 0.3289 | −190.1 | 0.6217 |
| −258.06 | 0.1460 | −244.6 | 0.3453 | −189.4 | 0.6250 |
| −257.69 | 0.1578 | −242.4 | 0.3637 | −186.1 | 0.6313 |
| −257.22 | 0.1815 | −237.9 | 0.3987 | −185.9 | 0.6356 |
| −257.16 | 0.1773 | −235.1 | 0.4324 | L. −177.7 | 0.7991 |
| −256.19 | 0.2004 | −228.7 | 0.4593 | −175.4 | 0.8016 |
| −255.85 | 0.2202 | −226.4 | 0.4711 | −174.2 | 0.8047 |
| −255.83 | 0.2239 | −223.4 | 0.4884 | −171.1 | 0.8090 |
| −255.23 | 0.2517 | −220.6 | 0.5026 | −167.8 | 0.8115 |
| −254.36 | 0.3184 | −217.4 | 0.5149 | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | 126.9 cal 15°/g at 246.1 mm (−173°56 according to HENNING and STOCK) | FRANK and CLUSIUS (1937—39) |
| *Heat of melting* | 13.973 cal 15°/g at −182°49 | CLUSIUS (1929) |
| | 13.964 „ | CLUSIUS and POPP (1940) (M. W. 16.041) |
| *Heat of transition* | 1.13 cal 15°/g at −252°66 | CLUSIUS (1929) |
| | 0.978 „ | CLUSIUS and POPP (1940) |
| *Heat of combustion* | 13267 cal 15°/g at 30° ($c_p$) | ROSSINI (1931) (corr.) |

## DEUTEROMETHANE $CD_4$

**Constants:** Clusius and Popp (1940) (M. W. used: 20.0624)

*Melting point:* −183°38

*Transition points:* II → I −246°06; III → II −250°91

*Triple point:* 78.9 mm

*Melting curve*

| t° | p atm. | t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|---|---|
| −179.21 | 168.25 | −181.00 | 94.5 | −181.69 | 67.1 | −183.39 | 39.6 |
| −179.49 | 156.7 | −181.07 | 91.9 | −181.71 | 66.2 | −183.43 | 38.2 |
| −179.85 | 142.5 | −181.20 | 86.3 | −181.93 | 57.6 | −183.67 | 28.2 |
| −180.16 | 128.75 | −181.21 | 86.1 | −182.95 | 56.6 | −183.90 | 18.9 |
| −180.46 | 117.0 | −181.24 | 85.6 | −183.18 | 47.85 | −184.17 | 8.4 |
| −180.68 | 107.65 | −181.45 | 76.6 | −183.19 | 47.6 | −184.38 | 0.104 |
| −180.98 | 95.0 | −181.46 | 76.35 | | | | |

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. III −261.98 | 0.06729 | −250.24 | 0.44062 | −243.25 | 0.37682 |
| −261.65 | 0.06878 | −250.02 | 0.32150 | −242.03 | 0.3808 |
| −259.78 | 0.08822 | −249.84 | 0.32748 | −241.63 | 0.38280 |
| −258.82 | 0.09969 | −248.92 | 0.39377 | −239.18 | 0.39028 |
| −257.99 | 0.11564 | −248.68 | 0.39925 | −238.72 | 0.3878 |
| −257.49 | 0.12660 | −248.59 | 0.39975 | −237.69 | 0.39377 |
| −256.37 | 0.14656 | −247.95 | 0.46206 | −234.66 | 0.40673 |
| −256.09 | 0.15352 | −247.59 | 0.52187 | −230.36 | 0.42268 |
| −255.52 | 0.16548 | −247.37 | 0.56324 | −227.12 | 0.43564 |
| −254.58 | 0.19539 | −246.86 | 0.70031 | −223.47 | 0.44511 |
| −254.48 | 0.19688 | −246.72 | 0.81744 | −220.07 | 0.45159 |
| −253.96 | 0.21134 | −246.62 | 0.82941 | −216.46 | 0.46256 |
| −253.76 | 0.21533 | −246.57 | 0.90717 | −208.79 | 0.47851 |
| −252.82 | 0.25421 | −246.34 | 1.4455 | −196.88 | 0.50243 |
| −251.47 | 0.36125 | −246.31 | 1.4554 | −192.71 | 0.51140 |
| −251.16 | 1.4854 | −246.24 | 1.7994 | −189.26 | 0.51788 |
| −251.06 | 2.1134 | −246.16 | 3.2000 | −188.63 | 0.51988 |
| −251.04 | 4.6505 | −246.11 | 3.6037 | L. −181.04 | 0.67190 |
| −251.01 | 5.6872 | C. I −246.02 | 1.9958 | −179.43 | 0.6739 |
| −251.01 | 6.3203 | −245.74 | 0.60412 | −178.14 | 0.6749 |
| C. II −250.95 | 2.8262 | −245.69 | 0.56224 | −173.08 | 0.68087 |
| −250.81 | 1.0916 | −245.08 | 0.39726 | −168.49 | 0.68587 |
| −250.29 | 0.50443 | −244.49 | 0.38480 | −164.22 | 0.68733 |

*Heat of melting*

10.751 cal 15°/g

*Heats of transition*

II → I 2.926 cal 15°/g

III → II 0.9869 cal 15°/g

## MONODEUTEROMETHANE $CH_3D$

**Constants:** Clusius and Popp (1940) (M. W. used: 17.0390)

*Melting point:* −182°74
*Triple point:* 84.5 mm
*Transition points:* II → I −249°97; III → II −257°28

*Melting curve*

| t° | p atm. | t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|---|---|
| −180.76 | 77.5 | −181.17 | 61.5 | −181.57 | 46.1 | −182.17 | 22.65 |
| −180.97 | 69.4 | −181.18 | 61.3 | −181.76 | 38.2 | −182.33 | 16.6 |
| −181.01 | 68.3 | −181.37 | 53.7 | −181.94 | 31.1 | −182.41 | 12.8 |

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. III −261.80 | 0.0599 | −251.28 | 0.430 | −233.90 | 0.407 |
| −261.31 | 0.0604 | −250.84 | 0.568 | −232.68 | 0.417 |
| −260.31 | 0.0775 | −250.57 | 0.582 | −231.71 | 0.422 |
| −260.06 | 0.0857 | −250.50 | 0.6960 | −229.47 | 0.435 |
| −258.66 | 0.133 | −250.35 | 0.7835 | −227.13 | 0.449 |
| −258.41 | 0.145 | −250.14 | 2.148 | −224.39 | 0.464 |
| −257.78 | 0.257 | −250.13 | 2.764 | −221.80 | 0.472 |
| −257.64 | 0.472 | −250.11 | 3.404 | −218.34 | 0.485 |
| −257.61 | 0.569 | −250.02 | 3.727 | −217.00 | 0.492 |
| −257.51 | 0.998 | −250.02 | 4.038 | −215.36 | 0.495 |
| −257.46 | 1.673 | −250.02 | 6.849 | −209.13 | 0.520 |
| −257.40 | 2.418 | C. I −249.71 | 0.6151 | −204.01 | 0.536 |
| C. II −257.28 | 1.027 | −249.33 | 0.335 | −200.74 | 0.552 |
| −257.27 | 0.878 | −248.66 | 0.318 | −194.48 | 0.565 |
| −257.17 | 0.529 | −248.10 | 0.317 | −189.77 | 0.587 |
| −257.11 | 0.245 | −247.55 | 0.322 | −186.70 | 0.595 |
| −256.46 | 0.167 | −246.52 | 0.329 | L. −180.70 | 0.7600 |
| −255.51 | 0.189 | −245.75 | 0.331 | −180.66 | 0.7629 |
| −255.36 | 0.194 | −243.56 | 0.345 | −176.79 | 0.7665 |
| −255.06 | 0.201 | −241.28 | 0.358 | −176.25 | 0.7723 |
| −254.16 | 0.229 | −239.68 | 0.370 | −175.98 | 0.7747 |
| −253.44 | 0.265 | −238.27 | 0.378 | −175.43 | 0.7847 |
| −253.09 | 0.282 | −237.92 | 0.381 | −172.84 | 0.7929 |
| −252.02 | 0.359 | −236.78 | 0.390 | | |
| −251.67 | 0.386 | −235.66 | 0.396 | | |

| *Heat of melting* | *Heats of transition* | |
|---|---|---|
| 12.76 cal 15°/g | II → I: 2.61 cal 15°/g | III → II: 0.798 cal 15°/g |

## ETHANE $C_2H_6$

The purification of this gas is as difficult as that of methane. Method No. 6 gives the best results (Cardoso and Bell, 1912).

The equation of state of ethane has been the subject of a critical survey by Sage, Webster and Lacey (1937).

### Constants

*Critical constants:* Survey by Pickering (1924)

| t° cr. | p cr. atm. | |
|---|---|---|
| 32.1 | 48.6 | Lu, Newitt and Ruhemann (1941) |
| 32.10 | 48.85 | Cardoso and Bell (1912) |
| 32.27 | 48.20 | Beattie, Su and Simard (1939) |

*Saturated vapour pressure*

| t° | p atm. | t° | p atm. | t° | p atm. | |
|---|---|---|---|---|---|---|
| −137.424 | 0.0245 | −97.452 | 0.6073 | −85.858 | 1.1619 | Loomis and Walters (1926) |
| −129.893 | 0.0522 | −95.437 | 0.6804 | −85.334 | 1.1881 | „ |
| −125.836 | 0.0762 | −94.539 | 0.7210 | −84.781 | 1.2289 | „ |
| −118.704 | 0.1400 | −93.410 | 0.7696 | −84.046 | 1.2761 | „ |
| −114.775 | 0.1886 | −91.654 | 0.8499 | −83.302 | 1.3264 | „ |
| −110.531 | 0.2573 | −90.697 | 0.8963 | −82.469 | 1.3900 | „ |
| −107.631 | 0.3160 | −89.382 | 0.9634 | −81.730 | 1.4347 | „ |
| −105.224 | 0.3693 | −88.521 | 1.0040 | −80.874 | 1.4974 | „ |
| −103.985 | 0.4033 | −88.023 | 1.0366 | −80.383 | 1.5340 | „ |
| −101.460 | 0.4743 | −87.146 | 1.0800 | −76.916 | 1.8110 | „ |
| −103.558 | 0.4430 | −86.551 | 1.1208 | −73.251 | 2.1441 | „ |
| − 99.098 | 0.5498 | | | | | „ |
| −88.69 | 0.9924 | −46.98 | 6.073 | −9.88 | 18.448 | Porter (1926) |
| −69.67 | 2.496 | −38.58 | 8.044 | −4.43 | 21.185 | „ |
| −67.54 | 2.733 | −35.26 | 9.229 | −0.07 | 23.544 | „ |
| −62.20 | 3.414 | −29.94 | 10.536 | +5.68 | 26.837 | „ |
| −56.85 | 4.225 | −24.51 | 12.354 | 10.42 | 30.106 | „ |
| −51.28 | 5.207 | −20.13 | 14.043 | 15.10 | 33.468 | „ |
| −48.06 | 5.838 | −14.36 | 16.421 | | | „ |
| 0 | 23.57 | 25 | 41.37 | — | — | Beattie, Hadlock and Poffenberger (1935) |

*Boiling point*

| | |
|---|---|
| −88°62 | Porter (1926) |
| −88°633 | Loomis and Walters (1926) |

*Melting curve*

| t° | p atm. | t° | p atm. | |
|---|---|---|---|---|
| −182.81 | 0.001 | −182.42 | 24.6 | Clusius and Weigand (1940) |
| −182.71 | 6.1 | −182.33 | 30.3 | „ |
| −182.59 | 13.2 | −182.23 | 36.5 | „ |
| −182.52 | 18.7 | −182.13 | 42.1 | „ |

*Weight of the normal litre in the gaseous state:* 1.3562 g Baume and Perrot (1909)

*Isotherms*

Beattie, Hadlock and Poffenberger (1935): (0.5 to 5 atm.; 25° to 250°)
Sage, Webster and Lacey (1937): (21° to 125°; until 250 kg)
Beattie, Su and Simard (1939): (50° to 275°)

## PROPANE $C_3H_8$

Prepared in the pure state by using butyronitrile and sodium (Timmermans, 1920). This gas is also obtained by fractionation of mixtures of natural gaseous hydrocarbons (Francis and Robbins, 1933). Survey of the thermodynamic properties: Sage (1934—36) (the properties of this gas are not yet well determined).

### Constants

*Critical constants:* Survey by Pickering (1924)

| t° cr | p cr. atm. | |
|---|---|---|
| 96.81 | 42.01 | Beattie, Hadlock and Poffenberger (1935) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −107.020 | 11.61 | −78.079 | 111.03 | −52.951 | 458.13 | Kemp and Egan (1938) |
| − 99.890 | 22.00 | −70.300 | 179.92 | −48.112 | 578.89 | „ |
| − 93.368 | 37.39 | −63.284 | 268.33 | −44.404 | 686.19 | „ |
| − 85.863 | 65.44 | −58.228 | 351.66 | −41.748 | 772.71 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| −42°12 | KEMP and EGAN (1938) | −42°2 | GROSSE (1937) |
| −42°17 | HICKS-BRUUN and BRUUN (1936) | −42°3 | FRANCIS and ROBBINS (1933) |

*Freezing point*

| | | | |
|---|---|---|---|
| −187°1 | HICKS-BRUUN and BRUUN (1936) | −187°71 | KEMP and EGAN (1938) |

*Weight of the normal litre in the gaseous state*

| | | |
|---|---|---|
| 0° | 2.02000 g | TIMMERMANS (1920) |
| 25° | 1.8324 g | KEMP and EGAN (1938) |

*Molecular Weight:* 44.096 CASADO, MASSIE and WHYTLAW-GRAY (1949).

*Isotherms:* BURGOYNE (1940) (−30° to 20° ; until 60 atm.)
REAMER, SAGE and LACEY (1949) (38° to 238° ; until 700 atm).

*Specific heat:* KEMP and EGAN (1938) (M. W. 44.092)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −256.80 | 0.01963 | −214.00 | 0.2117 | −158.05 | 0.4652 | −87.31 | 0.4979 |
| −253.56 | 0.03413 | −208.29 | 0.2288 | −150.24 | 0.4673 | −82.93 | 0.5031 |
| −250.05 | 0.05122 | −202.20 | 0.2467 | −144.31 | 0.4693 | −72.27 | 0.5088 |
| −246.59 | 0.06740 | −196.11 | 0.2653 | −137.26 | 0.4730 | −66.12 | 0.5111 |
| −242.65 | 0.08769 | −191.84 | 0.2771 | −130.42 | 0.4741 | −60.11 | 0.5174 |
| −238.58 | 0.1105 | | | −123.47 | 0.4780 | −53.96 | 0.5220 |
| −234.31 | 0.1329 | L. −183.49 | 0.4584 | −116.36 | 0.4809 | −48.25 | 0.5286 |
| −229.48 | 0.1516 | −177.68 | 0.4596 | −108.82 | 0.4845 | −43.40 | 0.5329 |
| −224.25 | 0.1723 | −171.25 | 0.4614 | −101.19 | 0.4873 | | |
| −218.68 | 0.1922 | −176.71 | 0.4632 | − 94.12 | 0.4920 | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B. P.) 101.8 cal 15°/g | KEMP and EGAN (1938) |
| *Heat of melting* | 19.11 „ | „ |

## *n*-BUTANE $n$-$C_4H_{10}$

The pure gas is prepared by the method of FRANKLAND and KOLBE (1848) or by the method of LEBEAU (1905).

SEIBERT and BURRELL (1915) succeeded in purifying, by fractional distillation at reduced pressure, the gas which had been prepared by action of zinc-copper couple on *n*-butyl iodide.

### Constants

*Critical constants:* Survey by PICKERING (1924)

| t° cr. | p cr. atm. | |
|---|---|---|
| 153.2 | 35.67 | SEIBERT and BURRELL (1915) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −78.043 | 9.90 | −10.883 | 503.34 | ASTON and MESSERLY (1940) |
| −60.482 | 36.26 | − 6.361 | 604.97 | „ |
| −46.874 | 85.59 | − 2.753 | 697.13 | „ |
| −37.328 | 145.58 | − 1.123 | 742.20 | „ |
| −26.639 | 249.53 | 0.344 | 764.50 | „ |
| −16.846 | 338.77 | | | „ |
| −67.7 | 23.5 | −17.7 | 384.5 | WACKHER, LINN and GROSSE (1945) |
| −60.0 | 42.5 | −11.3 | 498.0 | „ |
| −45.0 | 99.6 | − 7.1 | 589.3 | „ |
| −31.3 | 207.4 | 0.0 | 775.4 | „ |
| −22.7 | 310.9 | 5.6 | 955.0 | „ |
| 40 | 3350 | 100 | 12500 | SEIBERT and BURRELL (1915) |
| 50 | 4300 | 110 | 14700 | „ |
| 60 | 5400 | 120 | 18100 | „ |
| 70 | 6700 | 130 | 20600 | „ |
| 90 | 10700 | | | „ |

| | | |
|---|---|---|
| *Boiling point* | −0°50 | ASTON and MESSERLY (1940) |
| | −0°5 | GROSSE (1937) |
| *Melting point* | −138°29 | ASTON and MESSERLY (1940) |
| *Transition point* | −165°60 | „ |

*Weight of the litre in the gaseous state:* 2.5185 g 710 mm Beckers (1930)
Corrects the value given by Beckers (1927): 2.5192 g 710 mm
*Deviation from Avogadro's law:* (between 710 and 0 mm): 0.037039 Beckers (1930)

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. I −258.11 | 0.0136 | C. II −159.39 | 0.3427 | Aston and Messerly (1940) |
| −254.72 | 0.02600 | −154.36 | 0.3463 | „ (M. W.; 58.121) |
| −250.80 | 0.04227 | −146.38 | 0.3521 | „ |
| −246.45 | 0.05887 | −142.99 | 0.3568 | „ |
| −241.63 | 0.08134 | L. −133.28 | 0.4657 | „ |
| −236.27 | 0.1007 | −130.96 | 0.4665 | „ |
| −231.13 | 0.1200 | −123.66 | 0·4717 | „ |
| −224.29 | 0.1449 | −110.87 | 0.4767 | „ |
| −218.57 | 0.1619 | −104.67 | 0.4805 | „ |
| −213.54 | 0.1767 | − 87.53 | 0.4855 | „ |
| −212.44 | 0.1791 | − 76.33 | 0.4905 | „ |
| −207.81 | 0.1933 | − 69.92 | 0.4939 | „ |
| −206.89 | 0.1946 | − 57.22 | 0.5008 | „ |
| −200.86 | 0.2083 | − 50.45 | 0.5039 | „ |
| −198.19 | 0.2135 | − 42.35 | 0.5096 | „ |
| −193.84 | 0.2264 | − 34.73 | 0.5134 | „ |
| −187.40 | 0.2417 | − 26.15 | 0.5223 | „ |
| −180.88 | 0.2568 | − 21.73 | 0.5315 | „ |
| −174.99 | 0.2704 | − 11.12 | 0.5384 | „ |
| −169.61 | 0.2819 | − 5.02 | 0.5413 | „ |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 92.13 cal 15°/g | Aston and Messerly (1940) |
| *Heat of melting* | 19.176 cal 15°/g | „ |
| | 17.98 cal 15°/g | Huffman, Parks and Barmore (1931) |
| *Heat of transition* | 8.506 cal 15°/g | Aston and Messerly (1940) |
| | 8.7 cal 15°/g | Huffman, Parks and Barmore (1931) |

## *Iso*-BUTANE or 2-METHYLPROPANE $(CH_3)_2CH-CH_3$

Same remarks as for *n*-butane: the work of Hückel and Rassmann (1932) shows how difficult it is to prepare absolutely pure *iso*-butane.

## Constants

*Critical constants:* Survey by PICKERING (1924)

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 133.7 | 36.54 | — | SEIBERT and BURRELL (1915) |
| 133.8 | — | — | HARAND (1935) |
| 134.98 | 36.00 | 0.221 | BEATTIE, EDWARDS and MARPLE JR. (1949) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −85.090 | 11.37 | −22.071 | 498.08 | ASTON, KENNEDY and SCHUMANN (1940) |
| −71.704 | 31.96 | −18.761 | 572.67 | „ |
| −56.431 | 86.85 | −13.238 | 716.13 | „ |
| −44.107 | 174.26 | −11.609 | 763.44 | „ |
| −27.576 | 391.02 | | | „ |
| −66.7 | 48.3 | −22.7 | 491.2 | WACKHER, LINN and GROSSE (1945) |
| −58.0 | 83.8 | −15.0 | 666.7 | „ |
| −44.4 | 178.9 | −11.9 | 758.0 | „ |
| −35.8 | 271.3 | −10.4 | 799.1 | „ |
| −31.0 | 342.0 | | | „ |
| t° | p atm. | t° | p atm. | |
| 30 | 3.941 | 100 | 19.573 | BEATTIE, EDWARDS and MARPLE JR. (1949) |
| 50 | 6.701 | 125 | 30.440 | „ |
| 75 | 11.932 | | | „ |

| | | |
|---|---|---|
| *Boiling point* | −11°7 | WACKHER, LINN and GROSSE (1945) |
| | −11°72 | ASTON, KENNEDY and SCHUMANN (1940) |
| *Melting point* | −159°42 | ASTON, KENNEDY and SCHUMANN (1940) |

*Isotherms* in the critical region: BEATTIE, EDWARDS and MARPLE JR. (1949)

*Orthobaric liquid density*

| t° | d | t° | d | |
|---|---|---|---|---|
| 30 | 0.549 | 100 | 0.428 | BEATTIE, EDWARDS and MARPLE JR. (1949) |
| 50 | 0.518 | 125 | 0.353 | „ |
| 75 | 0.480 | | | „ |

*Specific heat:* Aston, Kennedy and Schumann (1940) (M. W.: 58.121)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.63 | 0.0114 | −207.43 | 0.19124 | L. −156.22 | 0.4108 | −77.06 | 0.4683 |
| −258.59 | 0.0197 | −204.74 | 0.19689 | −150.05 | 0.4151 | −71.64 | 0.4729 |
| −256.00 | 0.0314 | −198.59 | 0.21233 | −143.73 | 0.4168 | −66.60 | 0.4754 |
| −252.62 | 0.0455 | −190.94 | 0.22897 | −137.36 | 0.4217 | −61.53 | 0.4793 |
| −248.96 | 0.0615 | −188.85 | 0.23323 | −130.32 | 0.4260 | −56.38 | 0.4874 |
| −244.71 | 0.0802 | −186.69 | 0.23676 | −123.03 | 0.4313 | −50.89 | 0.4898 |
| −237.42 | 0.1066 | −181.96 | 0.24741 | −114.70 | 0.4383 | −45.85 | 0.4965 |
| −232.65 | 0.1243 | −180.47 | 0.24985 | −107.94 | 0.4451 | −40.27 | 0.5025 |
| −226.71 | 0.1427 | −175.65 | 0.2629 | −104.46 | 0.4463 | −34.59 | 0.5104 |
| −222.26 | 0.1556 | −169.55 | 0.2770 | −98.71 | 0.4506 | −28.12 | 0.5175 |
| −217.48 | 0.1683 | −165.66 | 0.2835 | −92.85 | 0.4569 | −21.22 | 0.5247 |
| −213.04 | 0.17855 | −162.59 | 0.2882 | −87.29 | 0.4611 | −16.14 | 0.5275 |
| −210.37 | 0.18509 | −160.58 | 0.3011 | −82.17 | 0.4651 | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B. P.) 87.634 cal 15° g | Aston, Kennedy and Schumann (1940) |
| *Heat of melting* | 18.689 cal 15°/g | „ |

## PARAFFINS from $C_5$ to $C_8$

The series of normal paraffins, from $C_5$ to $C_{12}$, has been the subject of a work by Shepard, Henne and Midgley (1931). The same substances, except pentane, were studied by Bruylants (unpublished data). B. E. has given data for some of them.

For all those hydrocarbons, the criteria of purity, besides the constancy of the boiling point, are:

a) the constancy of the freezing point.

b) the constancy of the pressure of isothermal liquefaction.

c) the value of the critical constants of vaporization.

d) the constancy of the critical solution point in nitrobenzene and aniline for successive fractions.

e) the constancy of the density of successive fractions.

### *n*-PENTANE $n$-$C_5H_{12}$

*Preparation of pure pentane*

Many data, attributed to *n*-pentane, refer to *iso*pentane; the old values concerning this substance are unreliable.

*n*-Pentane is prepared by two different methods, used for the first time by YOUNG (1899), YOUNG and THOMAS (1897) and YOUNG (1910).

a) Extraction from petroleum ether by mixed sulphuric and nitric acids, followed by fractional distillation over a very small range.
SHEPARD, HENNE and MIDGLEY (1931); PARKS and HUFFMAN (1930).
b) Synthesis: from the normal amyl alcohols through the corresponding iodide or bromide (MAIR, 1932) or by catalytic hydrogenation of the corresponding amylenes.
The physical constants of these different samples are very concordant.

SHEPARD's sample has been used by DORNTE and SMYTH (1930), but the values of the refractive index given by these authors differ from those of SHEPARD; for densities, if these authors agree between 0° and 30°, they do not with YOUNG for high temperatures and with TIMMERMANS for temperatures below 0°.

**Constants B. E. (1935). — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 197.2 | 25100 | 0.2323 | YOUNG (1910) |
| — | — | 0.23220 | TIMMERMANS (1920) |

*Densities of the liquid and the saturated vapour:* YOUNG (1900—10)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 30 | 0.6165 | 0.002451 | 170 | 0.4162 | 0.0735 |
| 40 | 0.6062 | 0.003361 | 180 | 0.3867 | 0.0935 |
| 50 | 0.5957 | 0.004545 | 186 | 0.3643 | 0.1109 |
| 60 | 0.5850 | 0.006020 | 190 | 0.3445 | 0.1269 |
| 70 | 0.5739 | 0.007862 | 193 | 0.3253 | 0.1440 |
| 80 | 0.5624 | 0.01012 | 195 | 0.3065 | 0.1609 |
| 90 | 0.5503 | 0.01289 | 196 | 0.2915 | 0.1746 |
| 100 | 0.5377 | 0.01626 | 196.5 | 0.2809 | 0.1841 |
| 110 | 0.5248 | 0.02024 | 196.8 | 0.2730 | 0.1925 |
| 120 | 0.5107 | 0.0250 | 196.9 | 0.2691 | 0.1960 |
| 130 | 0.4957 | 0.0310 | 197.0 | 0.2640 | 0.2005 |
| 140 | 0.4787 | 0.0386 | 197.1 | 0.2560 | 0.2090 |
| 150 | 0.4604 | 0.0476 | 197.15 | 0.2472 | 0.2168 |
| 160 | 0.4394 | 0.0591 | 197.2 | 0.2323 | 0.2323 |

*Rectilinear diameter*

($t°cr. \rightarrow 0°$): $0.3232 - 0.0004610\,t°$ YOUNG (1900—10)

($t°cr. \rightarrow$ M. P.) $0.44402 - 0.00043413\,T - 0.00000003477\,T^2$ TIMMERMANS (1912) (recalc. by YOUNG).

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −65.178 | 3.08 | − 9.793 | 115.07 | 14.653 | 344.63 | MESSERLY and KENNEDY |
| −47.811 | 12.03 | − 2.359 | 164.51 | 18.613 | 403.33 | „ (1940) |
| −39.537 | 21.14 | + 3.618 | 215.77 | 21.679 | 454.08 | „ |
| −27.420 | 44.64 | 9.621 | 279.80 | 24.828 | 511.64 | „ |
| −17.476 | 77.56 | | | | | „ |
| −30 | 37.95 | 90 | 3498 | 193 | 23540 | YOUNG (1910) |
| −20 | 67.85 | 100 | 4410 | 195 | 24225 | „ |
| −10 | 114.30 | 110 | 5483 | 196 | 24665 | „ |
| 0 | 183.25 | 120 | 6742 | 196.5 | 24850 | „ |
| 10 | 281.8 | 130 | 8187 | 196.8 | 24960 | „ |
| 20 | 420.2 | 140 | 9892 | 196.9 | 24995 | „ |
| 30 | 610.9 | 150 | 11805 | 197.0 | 25020 | „ |
| 40 | 873 | 160 | 14060 | 197.1 | 25060 | „ |
| 50 | 1193 | 170 | 16540 | 197.15 | 25090 | „ |
| 60 | 1605 | 180 | 19345 | 197.2 | 25100 | „ |
| 70 | 2119 | 186 | 21190 | | | „ |
| 80 | 2735 | 190 | 22500 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 36.0 | CUMMINGS, STONES and VOLANTE (1933) | 36.075 | HOWARDS, MEARS, FOOKSON, POMERANTZ and BROOKS (1947) |
| 36.0 | SHEPARD, HENNE and MIDGLEY (1931) | 36.077 | WOJCIECHOWSKI (1936) |
| 36.05 | MESSERLY and KENNEDY (1940) | 36°10 | B. E. (1935) |
| 36°05 | HUBBARD and BROWN (1943) | 36.15 | YOUNG (1897—1900) |
| 36°06 | MAIR (1932) | 36°15 | LECAT |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°388 | HOWARDS, MEARS, FOOKSON, POMERANTZ and BROOKS (1947) | 0°41 | B. E. (1935) |
| 0°39 | YOUNG (1897—1900) | 0.42 | WIBAUT, HOOG, LANGEDIJK, OVERHOFF and SMITTENBERG (1939) |
| 0°391 | WOJCIECHOWSKI (1936) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −129°69 | Messerly and Kennedy (1940) | −129°748 | Mair (1932) |
| −129°7 | Wibaut, Hoog, etc (1939) | −129°75 | Howard, Mears, etc. (1947) |
| −129°7 | Parks and Huffman (1930) | −129°753 | Glasgow, Murphy, Willingham and Rossini (1946) |

N.B. The value by B. E. (1935) −129°1 is too high owing to an inaccuracy in the thermometric scale in that region.

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NO_2$ | 24°5 | B. E. (1935) |
| in $C_6H_5NH_2$ | 71°4 | Shepard, Henne and Midgley (1931) |
| | 71°7 | Wibaut, Hoog, etc. (1939) |

## Gaseous state

*Isotherms:* Young (1910) — (in the critical region): Sage and Lacey (1942).

## Liquid state

*Density*

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| −136.5 | 0.76827 | −74.25 | 0.71249 | −30.6 | 0.67391 | Timmermans (1912) |
| −123.3 | 0.75531 | −63.3 | 0.70298 | −22.9 | 0.66682 | „ |
| −116.2 | 0.74930 | −53.6 | 0.69483 | −13.1 | 0.65766 | „ |
| −111.6 | 0.74541 | −45.0 | 0.68724 | − 6.2 | 0.65120 | „ |
| −104.85 | 0.73952 | −37.2 | 0.67981 | 0.0 | 0.64537 | „ |
| − 94.5 | 0.73085 | −35.3 | 0.67847 | 15.0 | 0.63106 | „ |
| − 83.4 | 0.72097 | | | | | „ |

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.64539 | Young (1897—1900) | 0 | 0.64543 | B. E. (1935) |
| 10 | 0.6360 | „ | 15 | 0.63114 | „ |
| 20 | 0.6263 | „ | 30 | 0.61607 | „ |
| 30 | 0.6165 | „ | | | |
| 10 | 0.6359 | Dornte and Smyth (1930) | 20 | 0.62619 | Howard, Mears, etc. (1947) |
| 20 | 0.6263 | „ | 20 | 0.62632 | Shepard, Henne and Midgley (1931) |
| 30 | 0.6163 | „ | | | |
| 15 | 0.63109 | Wibaut, Hoog, etc. (1939) | 25 | 0.6213 | Hubbard and Brown (1943) |
| 30 | 0.62624 | „ | 25 | 0.62133 | Howard, Mears, etc. (1947) |

*Viscosity*

| t° | $\eta . 10^5$ | | t° | $\eta . 10^5$ | |
|---|---|---|---|---|---|
| 15 | 241 | B. E. (1935) | 25 | 229.6 | Hubbard and Brown (1943) |
| 30 | 205 | „ | 50 | 187.9 | „ |
| 20 | 227 | Geist and Cannon (1946) | 25 | 216.6 | Shepard, Henne and Midgley (1931) |

*Surface tension*

| t° | γ | | t° | γ | |
|---|---|---|---|---|---|
| 15 | 16.63 | B. E. (1935) | 20 | 15.98 | Wibaut, Hoog, etc. (1939) |
| 20 | 16.00 | „ | | | |
| 30 | 15.00 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.35822 | 1.35862 | 1.36033 | 1.36051 | 1.36401 | 1.36495 | 1.36763 | — | B. E. (1935) |
| $\frac{dn}{dt}$ | 0.00055 | 55 | — | 55 | 56 | 56 | 58 | — | „ |
| 15 | — | 1.35866 | 1.36058 | — | — | 1.36490 | — | 1.36849 | Wibaut, Hoog, etc. |
| 20 | — | 1.35587 | 1.35769 | — | — | 1.36200 | — | 1.36561 | „ (1939) |
| $\frac{dn}{dt}$ | — | 0.00056 | 58 | — | — | 58 | — | 58 | „ |
| 20 | — | 1.35581 | 1.35769 | — | — | 1.36208 | — | — | Shepard, Henne, etc. |
| 25 | — | 1.35309 | 1.35495 | — | — | 1.35930 | — | — | „ (1931) |
| $\frac{dn}{dt}$ | — | 0.00054 | 55 | — | — | 56 | — | — | „ |
| 20 | — | — | 1.35746 | — | — | — | — | — | Howard, Mears, etc. |
| 25 | — | — | 1.35480 | — | — | — | — | — | „ (1947) |
| $\frac{dn}{dt}$ | — | — | 0.00053 | — | — | — | — | — | „ |
| 20 | — | — | 1.3577 | — | — | — | — | — | Woodburn, Smith and Tetewsky (1944) |
| 25 | — | — | 1.35470 | — | — | — | — | — | Mair (1932) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. −260.75 | 0.01039 | −137.12 | 0.2993 | Messerly and Kennedy (1940) (M.W. |
| −258.45 | 0.01621 | −135.54 | 0.3099 | „ 72.146) |
| −254.64 | 0.02900 | −133.58 | 0.3169 | „ |
| −250.37 | 0.04446 | L. −121.84 | 0.4663 | „ |
| −245.61 | 0.06041 | −116.19 | 0.4673 | „ |
| −240.30 | 0.08128 | −110.39 | 0.4690 | „ |
| −235.16 | 0.09712 | −104.78 | 0.4692 | „ |
| −230.26 | 0.1112 | − 98.96 | 0.4701 | „ |
| −224.49 | 0.1290 | − 93.09 | 0.4709 | „ |
| −219.12 | 0.14431 | − 87.45 | 0.4731 | „ |
| −214.17 | 0.16078 | − 82.63 | 0.4749 | „ |
| −208.19 | 0.1745 | − 76.49 | 0.4759 | „ |
| −205.14 | 0.18286 | − 66.11 | 0.4815 | „ |
| −199.07 | 0.19647 | − 57.32 | 0.4849 | „ |
| −191.94 | 0.21073 | − 47.00 | 0.4898 | „ |
| −185.39 | 0.2239 | − 38.35 | 0.4980 | „ |
| −179.59 | 0.2352 | − 28.61 | 0.5068 | „ |
| −173.67 | 0.2444 | − 18.94 | 0.5132 | „ |
| −167.39 | 0.2554 | − 10.60 | 0.5224 | „ |
| −160.42 | 0.2667 | − 3.15 | 0.5274 | „ |
| −154.03 | 0.2756 | + 5.92 | 0.5446 | „ |
| −147.52 | 0.2855 | + 13.25 | 0.5527 | „ |
| −141.33 | 0.2945 | | | „ |
| C. −180.36 | 0.233 | −103.26 | 0.468 | Parks and Huffman (1930) |
| −175.56 | 0.243 | − 87.66 | 0.473 | „ |
| −170.46 | 0.251 | − 72.76 | 0.479 | „ |
| −164.56 | 0.261 | − 58.26 | 0.485 | „ |
| −158.36 | 0.271 | − 41.96 | 0.494 | „ |
| −152.16 | 0.282 | − 12.96 | 0.514 | „ |
| −146.46 | 0.292 | + 1.64 | 0.528 | „ |
| −140.96 | 0.306 | 6.04 | 0.531 | „ |
| L. −123.26 | 0.465 | 11.54 | 0.536 | „ |
| −119.06 | 0.465 | 16.84 | 0.540 | „ |
| −110.76 | 0.468 | | | „ |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 85.38 cal 15°/g | Pitzer (1941) |
| | „ 86.86 cal 15°/g | Messerly and Kennedy (1940) |
| *Heat of melting* | 27.75 cal 15°/g | Parks and Huffman (1930) |
| | 27.894 cal 15°/g | Messerly and Kennedy (1940) |
| *Heat of combustion* | 25° ($c_p$) 11625.1 cal 15°/g | Prosen and Rossini (1944) (M.W. 72.146) |

## *Iso*-PENTANE $(CH_3)_2CH-CH_2-CH_3$

*Preparation in a state of purity*

According to Young (1895 – 1899), Young and Thomas (1897) and Young (1910), pure *iso*pentane may be obtained:

1. by fractionation of petroleum ether until constancy of the properties. The samples of *iso*pentane used by many authors were derived from petroleum ether, but as the fractionation was generally not carried out until a perfectly definite product was obtained, almost all results recorded in the literature on this subject must be accepted with caution.
2. by dehydration of *iso*amyl alcohol into the corresponding amylene and catalytic hydrogenation of the latter.
3. by reduction of *iso*amyl iodide.

Parks' sample is possibly less pure than ours, since it is a Kahlbaum product submitted to fractional distillation, but without any preliminary chemical treatment; while Eykman's sample is a Kahlbaum product, distilled over sodium but not fractionated.

**Constants:** B. E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d. cr. | |
|---|---|---|---|
| 187.8 | 25020 | 0.2343 | Young (1900) |
| — | — | 0.23444 | Timmermans (1920) |

*Densities of the liquid and the saturated vapour:* Young (1910)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.63930 | 0.0011 | 130 | 0.4826 | 0.03831 |
| 10 | 0.6295 | 0.001650 | 140 | 0.4642 | 0.04728 |
| 20 | 0.6196 | 0.002344 | 150 | 0.4445 | 0.05834 |
| 30 | 0.6092 | 0.003266 | 160 | 0.4206 | 0.07289 |
| 40 | 0.5988 | 0.004456 | 170 | 0.3914 | 0.09337 |
| 50 | 0.5881 | 0.005956 | 176 | 0.3694 | 0.1101 |
| 60 | 0.5769 | 0.007836 | 180 | 0.3498 | 0.1258 |
| 70 | 0.5656 | 0.01013 | 183 | 0.3311 | 0.1418 |
| 80 | 0.5540 | 0.01287 | 185 | 0.3142 | 0.1574 |
| 90 | 0.5413 | 0.01621 | 186 | 0.3028 | 0.1676 |
| 100 | 0.5278 | 0.02020 | 187 | 0.2857 | 0.1833 |
| 110 | 0.5140 | 0.02513 | 187.4 | 0.2761 | 0.1951 |
| 120 | 0.4991 | 0.03106 | 187.8 | 0.2343 | 0.2343 |

*Rectilinear diameter*

(between t° cr. and 0°) $0.3202 - 0.0004658\ t° + 0.0000000463\ t°^2$ YOUNG (1900–1910)
(between t° cr. and freezing point) $0.44806 - 0.00047586\ T° + 0.00000002664\ T°^2$ TIMMERMANS (1912) (recalc. by Young)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −55.854 | 10.95 | −17.399 | 114.89 | 8.471 | 369.37 | SCHUMANN, ASTON and |
| −41.739 | 29.08 | − 9.556 | 168.56 | 13.827 | 456.51 | SAGENKAHN (1942) |
| −34.349 | 45.67 | − 2.663 | 231.49 | 19.048 | 556.43 | „ |
| −27.828 | 66.28 | + 3.780 | 304.43 | 22.036 | 620.98 | „ |
| −22.766 | 87.14 | | | | | „ |
| −30 | 58.55 | 70 | 2556.7 | 170 | 19115 | YOUNG (1910) |
| −20 | 100 | 80 | 3383.0 | 176 | 20970 | „ |
| −10 | 164.15 | 90 | 4281.3 | 180 | 22270 | „ |
| 0 | 257.35 | 100 | 5345.5 | 183 | 23310 | „ |
| 10 | 390.4 | 110 | 6583.8 | 185 | 24000 | „ |
| 20 | 572.2 | 120 | 8018.0 | 186 | 24370 | „ |
| 30 | 819.0 | 130 | 9684.0 | 187 | 24730 | „ |
| 40 | 1140.5 | 140 | 11634 | 187.4 | 24880 | „ |
| 50 | 1535.7 | 150 | 13802 | 187.8 | 25018 | „ |
| 60 | 2036.5 | 160 | 16320 | | | „ |

| t° | p mm | |
|---|---|---|
| 0.32 | 260.6 | ROLAND (1928) |
| 17 | 505 | HIRSHBERG (1932) |

*Boiling point*

| | | | |
|---|---|---|---|
| 27°78 | SCHUMANN, ASTON and SAGENKAHN (1942) | 27°92 | GUTHRIE JR. and HUFFMAN (1943) |
| 27°80 | WIBAUT, HOOG, LANGEDYK, OVERHOFF and SMITTENBERG (1939) | 27°95 | YOUNG (1910) |
| 27°853 | HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947) | 27°95 | B. E. (1926) and LECAT (passim) |
| | | 28°0 | PARKS, HUFFMAN and THOMAS (1930) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°37 | B. E. (1926) | 0°386 | HOWARD, MEARS, etc. (1947) |
| 0°38 | YOUNG (1902—10) | 0°40 | WIBAUT, HOOG, etc. (1939) |

*Freezing point*

| | | | |
|---|---|---|---|
| −159°77 | Schumann, Aston and Sagenkahn (1942) | −159°922 | Glasgow, Murphy, Willingham and Rossini (1946) |
| −159°79 | Guthrie Jr. and Huffman (1943) | −160·0 | Timmermans, Van der Horst and Kamerlingh Onnes (1922) |
| −159·9 | Howard, Mears, etc. (1947) | −160°04 | Knowlton and Rossini (1939) |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NO_2$ | 32°1 | B. E. (1926) |
| in $C_6H_5NH_2$ | 78°9 | Wibaut, Hoog, etc. (1939) |

*Isotherms:* Young (1910)

**Constants of state**

*Density*

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| −158.05 | 0.78714 | −83.4 | 0.71719 | −30.6 | 0.66880 | Timmermans (1912) |
| −136.5 | 0.76661 | −74.25 | 0.70884 | −22.95 | 0.66140 | „ |
| −123.3 | 0.75323 | −63.3 | 0.69891 | −13.1 | 0.65192 | „ |
| −116.2 | 0.74691 | −53.6 | 0.69035 | — 6.2 | 0.64588 | „ |
| −111.6 | 0.74281 | −45.0 | 0.68238 | 0 | 0.63943 | „ |
| −104.85 | 0.73672 | −37.2 | 0.67493 | 15 | 0.62463 | „ |
| −94.5 | 0.72760 | −35.3 | 0.67335 | | | |

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.63945 | B. E. (1926) | 15 | 0.62473 | Wibaut, Hoog, |
| 15 | 0.62470 | „ | 20 | 0.61972 | „ etc. (1939) |
| 0 | 0.63930 | Young (1910) | 20 | 0.61963 | Howard, Mears, |
| 15 | 0.6245 | „ | 25 | 0.61455 | „ etc. (1947) |
| 15.2 | 0.6257 | Eykman (1906) | | | |
| 19.1 | 0.6206 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 0 | 274 | B. E. (1926) |
| 15 | 234 | „ |

*Surface tension*

| t° | γ | |
|---|---|---|
| 10 | 16.10 | HENNAUT-ROLAND and LEK (1931) |
| 15 | 15.54 | „ |
| 20 | 15.00 | „ |
| 20 | 14.97 | WIBAUT, HOOG, etc. (1939) |

*Refractive index*

| t° | He r. | H α | D | He y. | He g. | H β | He bl. | He v. | H γ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4.2 | 1.35552 | 1.35578 | — | 1.35761 | 1.36111 | 1.36195 | 1.36285 | 1.36450 | 1.36552 | EYKMAN (1906) |
| 5 | 1.35472 | 1.35505 | 1.35691 | 1.35700 | 1.36052 | 1.36147 | — | 1.36413 | — | B. E.* |
| $\frac{n}{t}$ | 0.00055 | 55 | — | 55 | 55 | 57 | — | 58 | — | „ |
| 5 | — | 1.35509 | 1.35691 | — | — | 1.36125 | — | — | 1.36487 | WIBAUT,, HOOG, etc. (1939) |
| 0 | — | 1.35218 | 1.35396 | — | — | 1.35827 | — | — | 1.36182 | „ |
| $\frac{n}{t}$ | — | 0.00058 | 59 | — | — | 60 | — | — | — | „ |
| 0 | — | — | 1.35357 | — | — | — | — | — | — | HOWARD, MEARS, etc. (1947) |
| 5 | — | — | 1.35067 | — | — | — | — | — | — | „ |
| $\frac{\Delta n}{\Delta t}$ | — | — | 0.00058 | — | — | — | — | — | — | „ |

* These values correct the values of B.E. (1926)

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. −259.96 | 0.01551 | −210.57 | 0.1790 | GUTHRIE Jr. and HUFFMAN (1943) |
| −256.74 | 0.02711 | −206.85 | 0.1908 | „ (M. W. 72.146) |
| −253.96 | 0.03811 | −203.92 | 0.2015 | „ |
| −250.26 | 0.05350 | −197.15 | 0.2049 | „ |
| −246.22 | 0.06976 | −194.21 | 0.2098 | „ |
| −241.24 | 0.08875 | −190.66 | 0.2177 | „ |
| −235.51 | 0.1084 | −186.69 | 0.2269 | „ |
| −229.75 | 0.1257 | −182.64 | 0.2367 | „ |
| −223.96 | 0.1419 | −177.72 | 0.2486 | „ |
| −218.37 | 0.1566 | −171.74 | 0.2647 | „ |
| −214.57 | 0.1672 | −165.48 | 0.2843 | „ |

*Specific heat* (continued)

| | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|
| L. | 157.49 | 0.4086 | −52.56 | 0.4715 | Guthrie Jr. and Huffman (1943) |
| | −150.29 | 0.4125 | −43.16 | 0.4795 | (M. W. 72.146) |
| | −139.22 | 0.4185 | −33.90 | 0.4866 | „ |
| | −123.90 | 0.4267 | −24.79 | 0.4945 | „ |
| | −113.36 | 0.4322 | −15.82 | 0.5029 | „ |
| | −103.00 | 0.4383 | −5.26 | 0.5138 | „ |
| | −92.81 | 0.4442 | −1.28 | 0.5180 | „ |
| | −82.78 | 0.4505 | +7.19 | 0.5266 | „ |
| | −72.91 | 0.4570 | 15.60 | 0.5352 | „ |
| | −62.11 | 0.4644 | 24.65 | 0.5448 | „ |
| C. | −233.16 | 0.100 | −133.16 | 0.4214 | Schumann, Aston and Sagenkahn |
| | −228.16 | 0.117 | −123.16 | 0.4261 | „ (1942) (M. W. 72.146) |
| | −223.16 | 0.131 | −113.16 | 0.4308 | „ |
| | −218.16 | 0.1444 | −103.16 | 0.4366 | „ |
| | −213.16 | 0.1577 | −87.16 | 0.4432 | „ |
| | −203.16 | 0.1717 | −33.16 | 0.4882 | „ |
| | −193.16 | 0.2081 | −23.16 | 0.4978 | „ |
| | −183.16 | 0.2352 | −13.16 | 0.5075 | „ |
| | −173.16 | 0.2609 | − 3.16 | 0.5183 | „ |
| | −163.16 | 0.2878 | + 6.84 | 0.5314 | „ |
| L. | −153.16 | 0.4117 | 16.84 | 0.5616 | „ |
| | −143.16 | 0.4160 | | | „ |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 81.533 cal 15°/g | Schumann, Aston and Sagenkahn (1942) |
| *Heat of melting* | | 16.94 cal 15°/g | Parks, Huffman and Thomas (1930) |
| | | 17.010 cal 15°/g | Schumann, Aston and Sagenkahn (1942) |
| | | 17.050 cal 15°/g | Guthrie Jr. and Huffman (1943) |
| *Heat of combustion* | 25° ($c_p$) | 11689.8 cal 15°/g | Knowlton and Rossini (1939) (M. W. 72.146) |

## TETRAMETHYLMETHANE OR 2.2-DIMETHYL *n*-PROPANE $C(CH_3)_4$

Prepared by the action of zinc-methyl or methylmagnesium bromide on *tertiary* butyl bromide. Whitmore and Fleming (1933).

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −42.0 | 87.1 | −21.7 | 222.0 | −13.4 | 316.5 | Whitmore and Fleming |
| −38.0 | 104.6 | −19.4 | 247.0 | −8.0 | 394.0 | „ (1933) |
| −33.1 | 135.1 | −17.6 | 269.8 | −1.0 | 523.7 | „ |
| −30.5 | 155.6 | −17.2 | 276.0 | +3.1 | 605.7 | „ |
| −28.1 | 172.1 | −15.8 | 286.9 | 9.4 | 760.0 | „ |
| −24.0 | 206.1 | | | | | „ |

| | | |
|---|---|---|
| *Boiling point* | 9°4 | Whitmore and Fleming (1933) |
| | 9°503 | Howard, Mears, Fookson, Pomerantz and Brooks (1947) |
| | 9°6 | De Darwent and Steacie (1948) |
| *Freezing point* | −16°550 | Streiff, Zimmermans, Soule, Butt, Sedlak, Willingham and Rossini (1948) |
| | −16°60 | Howard, Mears, etc. (1947) |

| *Refractive index* | t° | 0° | 2° | 4° | 6° |
|---|---|---|---|---|---|
| | $n_D$ | 1.3513 | 1.3498 | 1.3486 | 1.3476 |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 11651.5 cal 15°/g | Knowlton and Rossini (1939) (M. W. 72.146) |

## *n*-HEXANE $n$-$C_6H_{14}$

*Preparation in a state of purity*

1. from petroleum ether, by destruction of methylpentamethylene by means of hot fuming nitric acid, followed by fractional distillation.
2. by the action of sodium on *n*-propyl iodide; it is difficult to eliminate the last traces of the halogenated compound by treatment with concentrated sulphuric acid, and by boiling over sodium.
3. by dehydration of hexyl alcohol into hexene-2, and catalytic hydrogenation of the latter.

Chief papers: Thomas and Young (1895); Young (1898—1910); Faillebin (1924); Shepard, Henne and Midgley (1931) and Mair (1932)

**Constants:** B. E. (1928)

P. Bruylants, of the University of Louvain, has kindly communicated the unpublished results of his measurements on this compound.

### Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 234.7 | 22754 | 0.233 | Kay (1946) |
| 234.8 | 22510 | 0.2344 | Young (1910) |
| 234.8 | 22800 | — | Kelso and Felsing (1942) |

*Densities of the liquid and the saturated vapour* YOUNG (1910)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.6769 | 0.0002 | 140 | 0.5343 | 0.01866 |
| 10 | 0.6683 | 0.0004 | 150 | 0.5207 | 0.02299 |
| 20 | 0.6595 | 0.0006 | 160 | 0.5063 | 0.02833 |
| 30 | 0.6505 | 0.0009 | 170 | 0.4913 | 0.03472 |
| 40 | 0.6412 | 0.0013 | 180 | 0.4751 | 0.04228 |
| 50 | 0.6318 | 0.0018 | 190 | 0.4570 | 0.05155 |
| 60 | 0.6221 | 0.002488 | 200 | 0.4365 | 0.06329 |
| 70 | 0.6122 | 0.003367 | 210 | 0.4124 | 0.07899 |
| 80 | 0.6022 | 0.00446 | 220 | 0.3810 | 0.1011 |
| 90 | 0.5918 | 0.00585 | 226 | 0.3557 | 0.1203 |
| 100 | 0.5814 | 0.00754 | 230 | 0.3329 | 0.1405 |
| 110 | 0.5703 | 0.00956 | 233 | 0.3040 | 0.1658 |
| 120 | 0.5588 | 0.01202 | 234 | 0.2883 | 0.1807 |
| 130 | 0.5467 | 0.01504 | 234.8 | 0.2344 | 0.2344 |

*Rectilinear diameter:* $0.3388 - 0.0004445\ t$ (between t cr. and 0°) YOUNG (1900—10)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| —99.0 | 0.009 | —76.2 | 0.119 | —56.1 | 0.916 | —33.6 | 5.33 | DRÜCKER, JIMENO and KANGRO (1915) |
| —98.4 | 0.010 | —64.4 | 0.397 | —51.5 | 1.29 | —21.6 | 12.55 | |
| —83.0 | 0.050 | —57.8 | 0.750 | —50.9 | 1.395 | —10.7 | 25.04 | |
| —80.6 | 0.067 | —57.3 | 0.796 | —43.9 | 2.44 | — 2.8 | 39.15 | „ |
| —66.4 | 0.327 | —62.3 | 0.482 | —56.3 | 0.880 | —47.4 | 1.913 | MÜNDEL (1913) |
| —64.7 | 0.396 | —58.8 | 0.687 | —49.6 | 1.606 | —46.9 | 2.002 | „ |
| —30 | 6.95 | 50 | 400.9 | 130 | 3719 | 210 | 15577 | YOUNG (1910) |
| —20 | 14.10 | 60 | 566.2 | 140 | 4606 | 220 | 18100 | „ |
| —10 | 25.90 | 70 | 787.0 | 150 | 5610 | 226 | 19765 | „ |
| 0 | 45.45 | 80 | 1062 | 160 | 6793 | 230 | 20955 | „ |
| 10 | 75.00 | 90 | 1407 | 170 | 8123 | 233 | 21890 | „ |
| 20 | 120.0 | 100 | 1836 | 180 | 9651 | 234 | 22220 | „ |
| 30 | 185.4 | 110 | 2358 | 190 | 11380 | 234.8 | 22510 | „ |
| 40 | 276.7 | 120 | 2982 | 200 | 13349 | | | „ |
| 0 | 45.43 | 21.82 | 131.1 | 44.48 | 328.4 | 67.07 | 717.0 | SCHMIDT (1934) |
| 9.50 | 73.6 | 27.40 | 166.7 | 52.79 | 444.3 | 70.56 | 800.2 | „ |
| 16.42 | 102.3 | 37.78 | 255.1 | 59.41 | 558.1 | 77.48 | 985.2 | „ |
| 21.67 | 130.4 | | | | | | | |
| 13.033 | 87.74 | 28.528 | 175.90 | 49.803 | 402.45 | 68.067 | 744.09 | WILLINGHAM, TAYLOR, PIGNOCCO and ROSSINI (1945) |
| 16.576 | 103.65 | 33.631 | 217.19 | 56.030 | 500.72 | 68.540 | 755.27 | |
| 20.618 | 124.66 | 38.311 | 261.74 | 62.785 | 627.95 | 69.081 | 768.02 | |
| 24.717 | 149.41 | 43.967 | 324.94 | 67.554 | 732.10 | 69.541 | 779.41 | |

*Boiling point*

| | | | |
|---|---|---|---|
| 68°6 | Tongberg and Johnston (1933) | 68°740 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 68°68 | Stull (1937) | | |
| 68°70 | Mair (1932) | 68°75 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| 68°70 | Lemons and Felsing (1943) | | |
| 68°7 | Kay (1946) | | |
| 68°71 | Shepard, Henne and Midgley (1931) | 68°76 | Cramer and Milligan (1936) |
| | | 68°80 | B. E. (1928) |
| 68°733 | Wojciechowski (1936) | 68°8 | Lecat (passim) |
| 68°739 | Willingham, Taylor, Pignocco and Rossini (1945) | 68°92 | Schmidt (1934) |
| | | 68°95 | Young (1900) |
| | | 68°95 | Thiry (1925) |

$\frac{dt}{dp}$ (*10 mm*)

| | | | |
|---|---|---|---|
| 0°417 | Schmidt (1934) | 0°42 | Young (1902) |
| 0°419 | Wojciechowski (1939) | 0°42 | Shepard, Henne and Midgley (1931) |
| 0°4191 | Forziati, Glasgow Jr., Willingham and Rossini (1946) | 0°42 | Willingham, Taylor, Pignocco and Rossini (1945) |
| 0°420 | Wojciechowski (1936) | | |
| 0°42 | B. E. (1928) and Lecat (passim) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −95°1 | B. E. (1928) | −95°338 | Forziati, Glasgow Jr., etc. (1946) |
| −95°2 | Huffman, Parks and Barmore (1931) (corr. Huffman, Parks and Thomas, 1930) | −95°355 | Mair (1932) |
| | | −95°39 | Shepard, Henne and Midgley (1931) |
| −95°2 | Stull (1937) | | |
| −95°320 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −95°5 | Wibaut, Hoog, etc. (1939) |

*Triple point:* −95°32 Douslin and Huffman (1946)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NO_2$ | 20°60 | B. E. (1928) |
| | 21°0 | Timmermans (1910) |
| in $C_6H_5NH_2$ | 68°9 | Timmermans (1911) |
| | 69°0 | Shepard, Henne and Midgley (1931) |
| | 69°1 | Wibaut, Hoog, etc. (1939) |
| | 69°2 | Thiry (1925) |

*Isotherms:* Young (1910) and Kelso and Felsing (1942)

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| | | | 20 | 0.65937 | FORZIATI, GLASGOW Jr., etc. (1946) |
| 0 | 0.67696 | YOUNG (1900) | | | |
| 15 | 0.6639 | „ | 25 | 0.65481 | „ |
| 0 | 0.67704 | B. E. (1928) | 20 | 0.65943 | WIBAUT, HOOG, etc. (1939) |
| 15 | 0.66380 | „ | 25 | 0.65490 | „ |
| 30 | 0.65055 | „ | 20 | 0.6593 | QUAYLE, DAY and BROWN |
| 0 | 0.67706 | BRUYLANTS (unp.) | 30 | 0.6502 | „ (1944) |
| 15 | 0.66388 | „ | 40 | 0.6406 | „ |
| 30 | 0.65054 | „ | 20 | 0.6593 | TONGBERG and JOHNSTON (1933) |
| 20 | 0.65945 | SHEPARD, HENNE and MIDGLEY (1931) | 20 | 0.6594 | LEMONS and FELSING (1943) |
| 25 | 0.65502 | „ | 20 | 0.6595 | CRAMER and MILLIGAN (1936) |
| | | | 20 | 0.6595 | VOGEL (1946) |
| | | | 30 | 0.6507 | DORNTE and SMYTH (1930) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 337 | B. E. (1928) | 16.35 | 328 | DRAPIER (1911) |
| 30 | 278 | „ | 18.55 | 320 | „ |
| 25 | 293.7 | SHEPARD, HENNE and MIDGLEY (1931) | 20 | 318 | „ |
| | | | 21.40 | 313 | „ |
| | | | 23.22 | 310 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 18.94 | LEK (1930) and HENNAUT-ROLAND and LEK (1931) | 30 | 17.37 | QUAYLE, DAY and BROWN |
| 20 | 18.42 | | 40 | 16.35 | „ (1944) |
| 30 | 17.40 | „ | 0 | 20.52 | HARKINS and CHENG (1921) |
| 20 | 18.41 | WIBAUT, HOOG, etc. (1939) | 20 | 18.43 | |

*Refractive index*

| t° | He r. | H α | D | He y. | He g. | H β | He v. | H γ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.37527 | 1.37560 | 1.37743 | 1.37762 | 1.38122 | 1.38219 | 1.38508 | — | B. E. corr. B. E. (1928) |
| $\frac{dn}{dt}$ | 0.00050 | 50 | 50 | 50 | 52 | 52 | 52 | — | „ |
| 15 | 1.37533 | 1.37563 | 1.37745 | 1.37754 | 1.38118 | 1.38210 | 1.38480 | 1.38589 | Bruylants, (unp.) |
| 30 | 1.36786 | 1.36818 | 1.36997 | 1.37008 | 1.37314 | 1.37447 | 1.37724 | 1.37818 | „ |
| $\frac{dn}{dt}$ | 0.00049 | 50 | 50 | 50 | 53 | 51 | 50 | 51 | „ |
| 20 | | 1.37310 | 1.37506 | — | — | 1.37979 | — | — | Shepard, Henne |
| 25 | — | 1.37043 | 1.37230 | — | — | 1.37695 | — | — | and Midgley (1931) |
| 45.3 | — | 1.35924 | 1.36132 | — | — | 1.36567 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.000535 | 55 | — | — | 57 | — | — | „ |
| 20 | — | 1.37300 | 1.37499 | — | — | 1.37950 | — | 1.38325 | Wibaut, Hoog, etc. |
| 25 | — | 1.37034 | 1.37229 | — | — | 1.37676 | — | 1.38044 | „ (1939) |
| $\frac{dn}{dt}$ | — | 0.00053 | 54 | — | — | 55 | — | 56 | „ |
| 20 | — | — | 1.37486 | — | — | — | — | — | Forziati, Glasgow |
| 25 | — | — | 1.37226 | — | — | — | — | — | Jr., etc. (1946) |
| $\frac{dn}{dt}$ | — | — | 0.00052 | — | — | — | — | — | „ |
| 20 | — | 1.37308 | 1.37490 | — | — | 1.37951 | — | 1.38318 | Dornte and Smyth (1930) |
| 20 | — | 1.37333 | 1.37518 | — | — | 1.37974 | — | 1.38286 | Vogel (1946) |
| 20 | — | — | 1.3750 | — | — | — | — | — | Tongberg and Johnston (1933) |
| 20 | — | — | — | 1.3750 | — | — | — | — | Lemons and Felsing (1943) |
| 20 | — | — | 1.3751 | — | — | — | — | — | Woodburne, Smith and Tetewsky (1944) |
| 25 | — | — | 1.37224 | — | — | — | — | — | Mair (1932) |

*Dielectric constant*

| t° | ε | t° | ε | |
|---|---|---|---|---|
| −30 | 1.972 | 25 | 1.8889 | Le Fevre (1938) |
| −15 | 1.946 | 35 | 1.872 | „ |
| 0 | 1.925 | 45 | 1.858 | „ |
| 15 | 1.904 | 55 | 1.844 | „ |

*Dielectric constant* (continued)

| t° | ε | |
|---|---|---|
| 10 | 1.906 | Dornte and Smyth (1930) |
| 30 | 1.875 | „ |
| 50 | 1.844 | „ |

*Magnetic rotatory power:* Lowry (1913—14) (Young's sample)

## Heat constants

*Specific heat*

| t° | $c_p$ | | t° | $c_p$ | |
|---|---|---|---|---|---|
| C. −179.76 | 0.219 | | −109.66 | 0.328 | Huffman, Parks and Barmore (1931) |
| −174.16 | 0.227 | L. | −84.36 | 0.472 | „ |
| −158.16 | 0.251 | | −55.36 | 0.482 | „ |
| −141.76 | 0.274 | | + 2.24 | 0.521 | „ |
| −127.76 | 0.295 | | 3.04 | 0.523 | „ |
| −118.36 | 0.309 | | 20.34 | 0.536 | „ |
| C. −260.08 | 0.01093 | | −130.14 | 0.29239 | Douslin and Huffman (1946) (M. W. |
| −258.24 | 0.01514 | | −121.50 | 0.30501 | „ 86.172) |
| −255.98 | 0.02134 | | −119.73 | 0.30712 | „ |
| −254.92 | 0.02477 | | −111.84 | 0.31999 | „ |
| −253.20 | 0.02987 | | −111.76 | 0.32008 | „ |
| −249.96 | 0.04056 | | −105.66 | 0.33059 | „ |
| −249.68 | 0.04143 | | − 99.66 | 0.34591 | „ |
| −245.34 | 0.05607 | L. | −92.74 | 0.47170 | „ |
| −244.26 | 0.05973 | | −82.72 | 0.47306 | „ |
| −240.63 | 0.07203 | | −82.13 | 0.47343 | „ |
| −238.44 | 0.07926 | | −79.29 | 0.47394 | „ |
| −233.59 | 0.09471 | | −73.82 | 0.47464 | „ |
| −228.21 | 0.11091 | | −72.39 | 0.47597 | „ |
| −221.86 | 0.12884 | | −70.46 | 0.47665 | „ |
| −217.27 | 0.14058 | | −64.98 | 0.47770 | „ |
| −214.90 | 0.14700 | | −60.83 | 0.47963 | „ |
| −210.60 | 0.15726 | | −60.11 | 0.48066 | „ |
| −203.73 | 0.17245 | | −50.43 | 0.48438 | „ |
| −196.59 | 0.18752 | | −47.97 | 0.48580 | „ |
| −190.03 | 0.20042 | | −40.16 | 0.49029 | „ |
| −189.01 | 0.20245 | | −35.18 | 0.49417 | „ |
| −182.65 | 0.21433 | | −30.03 | 0.49741 | „ |
| −177.69 | 0.22238 | | −21.76 | 0.50286 | „ |
| −174.47 | 0.22749 | | −20.04 | 0.50568 | „ |
| −166.78 | 0.23945 | | −10.19 | 0.51120 | „ |
| −161.16 | 0.24764 | | − 8.21 | 0.51358 | „ |
| −158.60 | 0.25166 | | − 0.48 | 0.51961 | „ |
| −149.95 | 0.26425 | | + 5.08 | 0.52432 | „ |
| −141.25 | 0.27659 | | 9.07 | 0.52816 | „ |
| −139.39 | 0.27903 | | 17.71 | 0.53546 | „ |
| −131.72 | 0.28969 | | 27.82 | 0.54474 | „ |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 87.503 cal 15°/g | Osborne and Ginnings (1947) |
| | 25° | 85.9 „ | Lemons and Felsing (1943) |
| | 40° | 84.5 „ | „ |
| | 60° | 80.4 „ | „ |
| | 80° | 78.2 „ | „ |
| *Heat of melting* | | 34.26 „ | Stull (1937) |
| | | 36.277 „ | Douslin and Huffman (1946) |
| *Heat of combustion* | 30° ($c_p$) | 11540.3 „ | Jessup (1937) (M. W. 86.1674) |
| | 25° ($c_p$) | 11544.8 „ | „ |
| | 25° ($c_p$) | 11546.5 „ | Prosen and Rossini (1944) (M. W. 86.172) |

## ISOMERIC HEXANES

All were synthetised in the pure state by Chavanne and his collaborators. Van Risseghem (1921—24); Chavanne and Van Risseghem (1922).

### 2-METHYLPENTANE $CH_3-CH(CH_3)-CH_2-CH_2-CH_3$

Prepared in the pure state by hydrogenation of 4-methylpentene-2, obtained from methyl*iso*butylcarbinol.

**Constants — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 224.9 | 29.95 | Kay (1946) |

*Saturated vapour pressure:* Willingham, Taylor, Pignocco and Rossini (1945).

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 12.758 | 124.66 | 35.810 | 324.93 | 59.607 | 744.07 |
| 16.820 | 149.42 | 41.567 | 402.44 | 60.074 | 755.26 |
| 20.584 | 175.90 | 47.714 | 500.70 | 60.602 | 767.99 |
| 25.617 | 217.18 | 54.388 | 627.94 | 61.066 | 779.37 |
| 30.237 | 261.75 | 59.099 | 732.09 | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 60·13 | Kay (1946) | 60·267 | Wojciechowski (1939) |
| 60°19 | Bruun, Hicks-Bruun and Faulconer (1937) | 60°27 | Stull (1937) |
| 60°2 | Van Risseghem (1921) | 60°271 | Willingham, Taylor, Pignocco and Rossini (1945) and Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 60·266 | Howard, Mears, Fookson, Pomerantz and Brooks (1947) | 60°3 | Tongberg and Fenske (1933) |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°41 | Willingham, Taylor, etc. (1945) | 0·414 | Wojciechowski (1939) |
| | | 0°418 | Howard, etc. (1947) |

*Freezing point*

| | | | |
|---|---|---|---|
| −153°45 | Stull (1937) | −153°73 | Howard, Mears, Fookson, Pomerantz and Brooks (1947) |
| −153°680 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −154·0 | Bruun, Hicks-Bruun and Faulconer (1937) |
| −153°700 | Forziati, Glasgow Jr., Willingham and Rossini (1946) | | |
| −153°71 | Wojciechowski (1939) | | |

*Triple point:* −153°61 Douslin and Huffman (1946)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 74°5 | Thiry (1925) |
| | 74°7 | Van Risseghem (1921) |

*Isotherms:* Kelso and Felsing (1942)

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.6712 | Van Risseghem (1938) | 0 | 0.6711 | Chavanne and Van Risseghem (1922) |
| 15 | 0.6580 | ,, | 15 | 0.6583 | |
| 20 | 0 6536 | ,, | 15 | 0.6580 | Thiry (1925) |
| | | | 20 | 0.6536 | Kay (1946) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 0 | 371 | 25 | 295 | CHAVANNE and VAN RISSEGHEM (1922) |
| 15 | 324 | 30 | 280 | ,, |
| 20 | 310 | | | ,, |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.3725 | 1.37445 | 1.3792 | 1.3829 | VAN RISSEGHEM (1924–38) |
| 15 | — | 1.3745 | — | — | TONGBERG and FENSKE (1936) |
| 20 | — | 1.3722 | — | — | ,, |
| $\frac{dn}{dt}$ | — | 0.00046 | — | — | ,, |

**Heat constants**

*Specific heat:* DOUSLIN and HUFFMAN (1946) (M. W. 86.172)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.16 | 0.01309 | −220.74 | 0.13876 | L. −169.60 | 0.40152 | −89.36 | 0.43944 |
| −258.66 | 0.01657 | −217.79 | 0.14324 | −155.75 | 0.40683 | −79.34 | 0.44536 |
| −257.03 | 0.02208 | −210.54 | 0.15508 | −152.00 | 0.40828 | −69.47 | 0.45239 |
| −255.26 | 0.02805 | −205.05 | 0.16693 | −149.58 | 0.40914 | −59.76 | 0.45912 |
| −252.86 | 0.03592 | −198.66 | 0.17978 | −147.54 | 0.41080 | −50.20 | 0.46633 |
| −249.95 | 0.04602 | −191.46 | 0.19403 | −142.92 | 0.41194 | −40.80 | 0.47410 |
| −249.46 | 0.04796 | −186.95 | 0.20264 | −140.92 | 0.41326 | −31.54 | 0.48155 |
| −246.73 | 0.05710 | −184.80 | 0.20692 | −136.35 | 0.41489 | −21.54 | 0.49115 |
| −244.10 | 0.06592 | −180.58 | 0.21412 | −131.12 | 0.41760 | −10.82 | 0.50113 |
| −243.10 | 0.06913 | −178.54 | 0.21767 | −127.72 | 0.41964 | − 0.30 | 0.51104 |
| −239.28 | 0.08121 | −174.55 | 0.22467 | −120.40 | 0.42217 | +10.03 | 0.52140 |
| −239.27 | 0.08125 | −172.61 | 0.22789 | −117.09 | 0.42423 | 20.17 | 0.53256 |
| −234.74 | 0.09487 | −168.80 | 0.23415 | −109.37 | 0.42788 | 30.11 | 0.54254 |
| −233.00 | 0.09957 | −166.94 | 0.23714 | − 99.53 | 0.43372 | | |
| −228.94 | 0.11067 | −162.62 | 0.24438 | − 91.48 | 0.43807 | | |
| −226.36 | 0.11737 | −161.49 | 0.24630 | | | | |
| −222.97 | 0.13153 | | | | | | |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 20° 82.7 | cal 15°/g | LEMONS and FELSING (1943) |
| | 40° 80.5 | ,, | ,, |
| | 60° 76.5 | ,, | ,, |
| | 80° 74.7 | ,, | ,, |
| | 25° 82.836 | ,, | OSBORNE and GINNINGS (1947) |
| *Heat of melting* | 17.379 | ,, | DOUSLIN and HUFFMAN (1946) |

## 3-METHYLPENTANE $CH_3-CH_2-CH(CH_3)-CH_2-CH_3$

Prepared in the pure state by hydrogenation of 3-methylpentene-2 obtained from diethylketone.

### Constants

*Critical constants*

| t° cr. | p cr. at. | d cr. | |
|---|---|---|---|
| 231.2 | 30.83 | 0.235 | Kay (1946) |

*Boiling point*

| | | | |
|---|---|---|---|
| 63°18 | Cramer and Mulligan (1936) | 63°256 | Wojciechowski (1939) |
| 63°20 | Van Risseghem (1921) | 63°26 | Stull (1937) |
| 63°20 | Bruun, Hicks-Bruun and Faulconer (1937) | 63°30 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |

$\frac{dt}{dp}$ *(10 mm)* 0°418 Wojciechowski (1939)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 69°3 | Wibaut, Hoog, etc. (1939) |
| | 69°4 | Van Risseghem (1921) |
| | 69°6 | Thiry (1925) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.6819 | Chavanne and Van Risseghem (1922) | 20 | 0.6642 | Cramer and Mulligan (1936) |
| | | | 20 | 0.66435 | Wibaut, Hoog, etc. (1939) |
| 15 | 0.6690 | „ | 25 | 0.65978 | „ |
| 0 | 0.6820 | Van Risseghem (1938) | 20 | 0.66438 | Howard, Meaks, Fookson, Pomerantz and Brooks (1947) |
| 15 | 0.6687 | „ | | | |
| 20 | 0.6642 | „ | | | |
| 15 | 0.6690 | Bruun, Hicks-Bruun and Faulconer (1937) | 25 | 0.65972 | „ |
| | | | 20 | 0.6639 | Kelso and Felsing (1942) |
| 20 | 0.6640 | „ | 30 | 0.6550 | „ |
| 15 | 0.6687 | Thiry (1925) | 40 | 0.6460 | „ |
| 20 | 0.6640 | Kay (1946) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 0 | 394 | 25 | 307 | CHAVANNE and VAN RISSEGHEM (1922) |
| 15 | 339 | 30 | 292 | ,, |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 20 | 18.10 | WIBAUT, HOOG, etc. (1939) | 30 | 17.08 | KELSO and FELSING (1942) |
| 20 | 18.12 | KELSO and FELSING (1942) | 40 | 16.03 | ,, |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.3775 | 1.3793 | 1.3841 | 1.3878 | VAN RISSEGHEM (1938) |
| 15 | — | 1.3790 | — | — | BRUUN, HICKS-BRUUN and FAULCONER |
| 20 | — | 1.3764 | — | — | ,, (1937) |
| 25 | — | 1.3738 | — | — | ,, |
| $\frac{dn}{dt}$ | — | 0.00052 | — | — | ,, |
| 20 | 1.37470 | 1.37662 | 1.38114 | 1.38496 | WIBAUT, HOOG, etc. (1939) |
| 25 | 1.37197 | 1.37389 | 1.37842 | 1.38217 | ,, |
| $\frac{dn}{dt}$ | 0.00055 | 55 | 54 | 56 | ,, |
| 20 | — | 1.37646 | — | — | HOWARD, MEARS, etc. (1947) |
| 25 | — | 1.37376 | — | — | ,, |
| $\frac{dn}{dt}$ | — | 0.00054 | — | — | ,, |
| 20 | — | 1.3775 | — | — | CRAMER and MULLIGAN (1936) |

*Specific heat:* DOUSLIN and HUFFMAN (1946) (M. W. 86.172).

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|---|
| Gl. | −222.27 | 0.13811 | −180.55 | 0.39723 | −116.12 | 0.42174 | −42.50 | 0.46698 |
| and | −215.08 | 0.15551 | −173.59 | 0.39841 | −105.93 | 0.42674 | −30.72 | 0.47667 |
| L. | −204.86 | 0.17379 | −167.59 | 0.39920 | − 95.89 | 0.43219 | −18.27 | 0.48721 |
| | −202.38 | 0.19148 | −164.46 | 0.40047 | − 86.02 | 0.43818 | − 6.09 | 0.49824 |
| | −198.79 | 0.21023 | −158.82 | 0.40267 | − 76.28 | 0.44372 | + 5.84 | 0.51014 |
| | −196.01 | 0.30966 | −155.51 | 0.40396 | − 66.70 | 0.44989 | 17.52 | 0.52139 |
| | −193.35 | 0.39460 | −147.82 | 0.40699 | − 57.25 | 0.45627 | 28.98 | 0.53321 |
| | −188.57 | 0.39634 | −137.04 | 0.41289 | − 55.49 | 0.45728 | | |
| | −187.16 | 0.39713 | −126.49 | 0.41712 | − 47.94 | 0.46319 | | |

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## BI-*iso*-PROPYL or 2, 3-DIMETHYLBUTANE $(CH_3)_2CH-CH(CH_3)_2$

*Preparation in a state of purity*

a) by hydrogenation of tetramethylethylene obtained from pinacolic alcohol (VAN RISSEGHEM, 1924)

b) by the action of sodium on *iso*-propyl iodide (very bad yield) (YOUNG and FORTEY, 1900)

c) from acetone (BROOKS, HOWARD and CRAFTON, 1940).

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm. | d cr. | |
|---|---|---|---|
| 227.1 | 23560 | 0.241 | KAY (1946) |
| 227.35 | 23345 | 0.2411 | YOUNG (1900–10) |
| 227.4 | 23332 | — | KELSO and FELSING (1942) |

*Densities of the liquid and the saturated vapour:* YOUNG (1910).

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.67948 | 0.0004 | 140 | 0.5334 | 0.02364 |
| 10 | 0.6707 | 0.0006 | 150 | 0.5197 | 0.02825 |
| 20 | 0.6617 | 0.0009 | 160 | 0.5049 | 0.03521 |
| 30 | 0.6525 | 0.0013 | 170 | 0.4885 | 0.04292 |
| 40 | 0.6432 | 0.0018 | 180 | 0.4705 | 0.05218 |
| 50 | 0.6338 | 0.002571 | 190 | 0.4508 | 0.06361 |
| 60 | 0.6243 | 0.003479 | 200 | 0.4274 | 0.07831 |
| 70 | 0.6144 | 0.004619 | 210 | 0.3988 | 0.09862 |
| 80 | 0.6039 | 0.006024 | 216 | 0.3758 | 0.1163 |
| 90 | 0.5931 | 0.007782 | 220 | 0.3565 | 0.1321 |
| 100 | 0.5821 | 0.009921 | 223 | 0.3372 | 0.1488 |
| 110 | 0.5708 | 0.01248 | 225 | 0.3198 | 0.1640 |
| 120 | 0.5589 | 0.01555 | 226.5 | 0.2967 | 0.1849 |
| 130 | 0.5464 | 0.01927 | 227.35 | 0.2411 | 0.2411 |

*Rectilinear diameter:* $0.3401 + 0.0004445\ t - 0.0000000413\ t^2$ YOUNG (1900)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −10 | 45.20 | 80 | 1444 | 170 | 9806 | Young (1900–10) and |
| 0 | 75.95 | 90 | 1876 | 180 | 11535 | Young and Fortey (1900) |
| 10 | 123.45 | 100 | 2411 | 190 | 13475 | ,, |
| 20 | 190.55 | 110 | 3044 | 200 | 15693 | ,, |
| 30 | 285.1 | 120 | 3790 | 210 | 18208 | ,, |
| 40 | 411.6 | 130 | 4677 | 216 | 19848 | ,, |
| 50 | 584.8 | 140 | 5717 | 220 | 21009 | ,, |
| 60 | 807 | 150 | 6884 | 225 | 22588 | ,, |
| 70 | 1093 | 160 | 8256 | 227.35 | 23360 | |
| 14.256 | 149.42 | 39.150 | 402.44 | 57.790 | 755.26 | Willingham, Taylor, |
| 18.044 | 175.90 | 45.339 | 500.71 | 58.320 | 767.99 | Pignocco and Rossini |
| 23.099 | 217.18 | 52.060 | 627.94 | 58.789 | 779.37 | (1945). |
| 27.746 | 261.75 | 56.806 | 732.09 | | | ,, |
| 33.357 | 324.93 | 57.317 | 744.07 | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 57°97 | Lemons and Felsing (1943) | 58°02 | Stull (1937) |
| 57°988 | Forziati, Glasgow Jr., Willingham and Rossini (1946) | 58°022 | Wojciechowski (1939) |
| | | 58°03 | Kay (1946) |
| 57°999 | Brooks, Howard and Crafton (1940) | 58°06 | Van Risseghem (1921) |
| | | 58°1 | Young (1900–10) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°412 | Brooks, Howard and Crafton (1940) | 0°4173 | Forziati, Glasgow Jr., etc. (1946) |
| 0°417 | Wojciechowski (1939) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −128°798 | Forziati, etc. (1946) | −128°41 | Glasgow Jr., Murphy, Willingham and Rossini (1946) |

*Triple point:* −127°97 Douslin and Huffman (1946)

*Transition point:* −137°09 ,,

*Isotherms:* Young (1900–10), Young and Fortey (1900), Kelso and Felsing (1942)

## Constants of state

### *Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.67948 | YOUNG (1910) | 20 | 0.6614 | VAN RISSEGHEM (1938) |
| 10 | 0.6707 | „ | 20 | 0.66150 | BROOKS, HOWARD and CRAFTON (1940) |
| 15 | 0.6662 | „ | | | |
| 20 | 0.6617 | „ | 25 | 0.65699 | „ |
| 30 | 0.6525 | „ | 20 | 0.66164 | FORZIATI, GLASGOW Jr., etc. |
| 40 | 0.6432 | „ | 25 | 0.65702 | „ (1946) |
| 0 | 0.6795 | VAN RISSEGHEM (1938) | 20 | 0.6615 | KAY (1946) |
| 15 | 0.6659 | „ | 20 | 0.6615 | LEMONS and FELSING (1943) |

### *Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 0 | 495 | 25 | 361 | CHAVANNE and VAN RISSEGHEM (1922) |
| 15 | 409 | 30 | 342 | „ |

### *Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15° | 1.3790 | 1.3809 | 1.3855 | 1.38935 | VAN RISSEGHEM (1924–38) |
| 20° | — | 1.37490 | — | — | BROOKS, HOWARD and CRAFTON (1940) |
| 25° | — | 1.37212 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.000556 | — | — | „ |
| 20° | — | 1.37495 | — | — | FORZIATI, GLASGOW Jr., etc. (1946) |
| 25° | — | 1.37231 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00053 | — | — | „ |
| 20° | — | 1.3748 | — | — | LEMONS and FELSING (1943) |
| 20° | — | 1.3749 | — | — | MC ARDLE and ROBERTSON (1942) |

*Specific heat:* Douslin and Huffman (1946) (M. W. 86.172)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. I −259.42 | 0.01250 | −166.36 | 0.23242 | −76.59 | 0.43459 |
| −257.84 | 0.01701 | −159.59 | 0.24496 | −67.72 | 0.44071 |
| −257.70 | 0.01741 | −158.05 | 0.24659 | −66.47 | 0.44108 |
| −255.92 | 0.02274 | −153.15 | 0.25733 | −58.98 | 0.44641 |
| −253.49 | 0.03164 | −149.13 | 0.26522 | −50.36 | 0.45327 |
| −253.16 | 0.03251 | −147.24 | 0.26918 | −49.23 | 0.45409 |
| −250.35 | 0.04318 | −147.01 | 0.26991 | −41.87 | 0.46019 |
| −249.51 | 0.04620 | −141.71 | 0.28243 | −33.50 | 0.46718 |
| −247.06 | 0.05496 | C. II −135.55 | 0.38186 | −32.48 | 0.46768 |
| −245.47 | 0.06030 | −134.86 | 0.38130 | −25.25 | 0.47380 |
| −243.77 | 0.06592 | −134.02 | 0.38075 | −20.18 | 0.47835 |
| −240.89 | 0.07559 | L. −123.79 | 0.40322 | −17.11 | 0.48151 |
| −240.28 | 0.07753 | −122.15 | 0.40467 | −12.15 | 0.48553 |
| −236.44 | 0.08901 | −118.97 | 0.40669 | − 8.32 | 0.49025 |
| −235.50 | 0.09085 | −114.19 | 0.40956 | − 4.25 | 0.49349 |
| −232.07 | 0.1008 | −112.69 | 0.41008 | + 1.24 | 0.49848 |
| −227.20 | 0.1128 | −109.46 | 0.41287 | 3.54 | 0.50188 |
| −221.99 | 0.12485 | −104.76 | 0.41578 | 11.23 | 0.50895 |
| −220.64 | 0.12810 | −104.04 | 0.41661 | 18.81 | 0.51680 |
| −211.74 | 0.14676 | −103.26 | 0.41799 | 26.28 | 0.52459 |
| −202.30 | 0.16523 | −100.13 | 0.41909 | 33.30 | 0.53225 |
| −193.98 | 0.18141 | −95.51 | 0.42184 | | |
| −186.12 | 0.19638 | −94.00 | 0.42237 | | |
| −185.94 | 0.19712 | −85.60 | 0.42821 | | |
| −168.04 | 0.22952 | −84.21 | 0.42922 | | |

| | | | | |
|---|---|---|---|---|
| *Heat of vaporisation* | 20° | 81.0 | cal 15°/g | Lemons and Felsing (1943) |
| | 40° | 78.1 | ,, | ,, |
| | 60° | 74.9 | ,, | ,, |
| | 80° | 72.3 | ,, | ,, |
| *Heat of transition* | | 18.010 | ,, | Douslin and Huffman (1946) |
| *Heat of melting* | | 2.2212 | ,, | ,, |

## TRIMETHYLETHYLMETHANE or 2, 2-DIMETHYLBUTANE

$$CH_3-C(CH_3)_2-CH_2-CH_3$$

Prepared in a state of purity by hydrogenation of *tert.* butylacetylene obtained from pinacone. VAN RISSEGHEM (1922)

**Constants. — Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −62.16 | 1.91 | −22.87 | 33.11 | +2.14 | 121.60 | KILPATRICK and PITZER |
| −54.41 | 4.05 | −14.84 | 52.05 | 9.71 | 170.85 | „ (1946) |
| −43.25 | 8.90 | − 6.18 | 81.45 | 16.23 | 225.33 | „ |
| −32.46 | 18.52 | 0.00 | 110.12 | | | „ |
| 15.376 | 217.18 | 37.269 | 500.71 | 49.544 | 755.26 | WILLINGHAM, TAYLOR, |
| 19.946 | 261.75 | 43.893 | 627.95 | 50.074 | 768.00 | PIGNOCCO and ROSSINI |
| 25.472 | 324.93 | 48.575 | 732.09 | 50.329 | 779.38 | „ (1945) |
| 31.175 | 402.44 | 49.078 | 744.07 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 49°65 | PITZER (1941) | 49°733 | HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947) |
| 49°70 | WIBAUT, HOOG, LANGEDYK, OVERHOFF and SMITTENBERG (1939) | 49°741 | FORZIATI, GLASGOW Jr., WILLINGHAM and ROSSINI (1946) |
| 49°71 | FELSING and WATSON (1943) | 49°80 | STULL (1937) |
| 49°72 | VAN RISSEGHEM (1922) | 49°804 | WOJCIECHOWSKI (1939) |
| 49°72 | HICKS-BRUUN, BRUUN and FAULCONER (1939) | 49°81 | CRAMER and MULLIGAN (1936) |
| 49°731 | BROOKS, HOWARD and CRAFTON (1940) | | |

$\frac{dt}{dp}$ (10 *mm*)

| | | | |
|---|---|---|---|
| 0°407 | BROOKS, HOWARD and CRAFTON (1940) | 0°4117 | FORZIATI, GLASGOW Jr., WILLINGHAM and ROSSINI (1946) |
| 0°411 | WOJCIECHOWSKI (1939) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −98°7 | HICKS-BRUUN, BRUUN and FAULCONER (1939) | −99°991 | FORZIATI, GLASGOW Jr., WILLINGHAM and ROSSINI (1946) |
| −99°00 | KILPATRICK and PITZER (1946) | −100°06 | BROOKS, HOWARD and CRAFTON (1940) |
| −99°73 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) | | |

*Triple point:* —98°88 Douslin and Huffman (1946)

*Transition points*

| Low | High | |
|---|---|---|
| −146°35 | −132°28 | Kilpatrick and Pitzer (1946) |
| −146°35 | −132°37 | Douslin and Huffman (1946) |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 80°65 | Thiry (1925) |
| | 80°75 | Van Risseghem (1922) |
| | 81°2 | Wibaut, Hoog, etc. (1939) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.6677 | Chavanne and Van Risseghem (1922) | 20 | 0.64923 | Howard, Mears, etc. (1947) |
| | | | 25 | 0.64422 | „ |
| 15 | 0.6541 | „ | 20 | 0.64899 | Felsing and Watson (1943) |
| 0 | 0.6678 | Van Risseghem (1938) | 25 | 0.64433 | „ |
| 20 | 0.6491 | „ | 20 | 0.6494 | Hicks-Bruun, Bruun and Faulconer (1939) |
| 20 | 0.64919 | Wibaut, Hoog, etc. (1939) | | | |
| 25 | 0.64448 | „ | 25 | 0.64475 | „ |
| 20 | 0.64902 | Brooks, Howard and Crafton (1940) | 20 | 0.64916 | Forziati, etc. (1946) |
| | | | 20 | 0.6493 | Cramer and Mulligan (1936) |
| 25 | 0.64432 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 0 | 477 | 25 | 351 | Chavanne and Van Risseghem (1922) |
| 15 | 397 | 30 | 330 | „ |
| 20 | 375 | | | „ |

*Surface tension:* 20° 16.18 Wibaut, Hoog, etc (1939)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.3697 | 1.3716 | 1.3762 | 1.3801 | Van Risseghem (1924–38) |
| 20 | 1.36695 | 1.36887 | 1.37344 | 1.37719 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.36413 | 1.36611 | 1.37057 | 1.37430 | „ |
| $\frac{dn}{dt}$ | 0.00056 | 55 | 57 | 58 | „ |
| 20 | — | 1.36864 | — | — | Brooks, Howard and Crafton (1940) |
| 25 | — | 1.36592 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00054 | — | — | „ |
| 20 | — | 1.36876 | — | — | Forziati, Glasgow Jr., etc. (1946) |
| 25 | — | 1.36595 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00056 | — | — | „ |
| 20 | — | 1.36873 | — | — | Howard, Mears, etc. (1947) |
| 25 | — | 1.36585 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00058 | — | — | „ |
| 20 | — | 1.3689 | — | — | Hicks-Bruun, Bruun and Faulconer |
| 25 | — | 1.36613 | — | — | „ (1939) |
| $\frac{dn}{dt}$ | — | 0.00055 | — | — | „ |
| 20 | — | 1.3689 | — | — | Mc Ardle and Robertson (1942) |
| 20 | — | 1.3690 | — | — | Woodburn, Smith and Tetewski (1944) |

## Heat constants

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|
| C. I | −257.64 | 0.01972 | −234.39 | 0.09770 | Kilpatrick and Pitzer (1946) |
| | −256.62 | 0.02287 | −229.88 | 0.10857 | „ (M. W. 86.172) |
| | −255.20 | 0.02804 | −224.31 | 0.12152 | „ |
| | −253.49 | 0.03457 | −221.30 | 0.12805 | „ |
| | −252.06 | 0.03996 | −215.95 | 0.13883 | „ |
| | −250.60 | 0.04535 | −209.84 | 0.14962 | „ |
| | −248.58 | 0.05346 | −208.84 | 0.15107 | „ |
| | −246.23 | 0.06243 | −204.36 | 0.15978 | „ |
| | −244.49 | 0.06826 | −199.68 | 0.16802 | „ |
| | −241.38 | 0.07856 | −194.14 | 0.17791 | „ |
| | −238.49 | 0.08701 | −188.09 | 0.18973 | — |
| | −238.22 | 0.08800 | −187.19 | 0.19100 | — |

*Specific heat* (continued)

| t° | $c_p$ | | t° | $c_p$ | |
|---|---|---|---|---|---|
| —183.88 | 0.19682 | L. | —94.43 | 0.4179 | KILPATRICK and PITZER (1946) |
| —182.81 | 0.19914 | | —85.65 | 0.4243 | ,, (M. W. 86.172) |
| —180.84 | 0.20274 | | —76.05 | 0.4319 | ,, |
| —176.39 | 0.21086 | | —66.54 | 0.4384 | ,, |
| —174.76 | 0.21376 | | —57.44 | 0.4454 | ,, |
| —173.67 | 0.21563 | | —47.92 | 0.4540 | ,, |
| —169.46 | 0.22353 | | —36.51 | 0.4642 | ,, |
| —166.09 | 0.22875 | | —27.09 | 0.4726 | ,, |
| —162.47 | 0.23613 | | —18.30 | 0.4815 | ,, |
| —157.29 | 0.24497 | | —10.01 | 0.4892 | ,, |
| —154.71 | 0.25042 | | — 1.45 | 0.4984 | ,, |
| —149.43 | 0.26053 | | + 6.41 | 0.5070 | ,, |
| C. I —260.30 | 0.01099 | | —171.50 | 0.21956 | DOUSLIN and HUFFMAN (1946) |
| —258.41 | 0.01668 | | —163.93 | 0.23376 | ,, (M. W. 86.172) |
| —255.94 | 0.02510 | | —154.58 | 0.25139 | ,, |
| —252.67 | 0.03677 | L. | —95.91 | 0.41748 | ,, |
| —248.86 | 0.05106 | | —93.10 | 0.41881 | ,, |
| —244.74 | 0.06621 | | —92.08 | 0.42022 | ,, |
| —240.02 | 0.08139 | | —87.70 | 0.42284 | ,, |
| —234.40 | 0.09733 | | —82.90 | 0.42615 | ,, |
| —227.33 | 0.1142 | | —77.59 | 0.43043 | ,, |
| —220.54 | 0.12827 | | —67.67 | 0.43832 | ,, |
| —220.29 | 0.12882 | | —57.92 | 0.44573 | ,, |
| —219.94 | 0.12971 | | —48.23 | 0.45358 | ,, |
| —211.90 | 0.14530 | | —38.87 | 0.46092 | ,, |
| —208.28 | 0.15220 | | —29.62 | 0.46942 | ,, |
| —202.32 | 0.16311 | | —20.49 | 0.47813 | ,, |
| —196.73 | 0.17354 | | —11.52 | 0.48679 | ,, |
| —192.92 | 0.18048 | | — 2.70 | 0.49612 | ,, |
| —185.57 | 0.19454 | | + 5.17 | 0.50430 | ,, |
| —183.90 | 0.19759 | | 14.52 | 0.51294 | ,, |
| —174.03 | 0.21519 | | 22.94 | 0.52151 | ,, |

N.B. — For $C_{II}$ and $C_{III}$ (polymorphic forms), the values given by the two works disagree and are somewhat erratic.

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 76.794 cal 15°/g | OSBORNE and GINNINGS (1947) |
| | 50° | 73.8 ,, | PITZER (1941) |
| *Heats of transition* | Low (—146°) | High (—132°) | |
| | 14.950 | 0.786 cal 15°/g | KILPATRICK and PITZER (1946) |
| | 15.001 | 0.7914 ,, | DOUSLIN and HUFFMAN (1946) |
| *Heat of melting* | | 1.6061 | KILPATRICK and PITZER (1946) |
| | | 1.607 | DOUSLIN and HUFFMAN (1946) |

## *n*-HEPTANE $n$-$C_7H_{16}$

*Preparation in a state of purity*

a) from the essential oil of "*Pinus Sabiniana*" and purification by mixed sulphuric and nitric acid (THORPE, 1880)
b) by reduction of oenanthol (CLEMMENSEN, 1913)
c) by reduction of *n*-heptyl bromide or iodide by sodium ammonium (EDGAR, CALINGAERT and MARKER, 1929).

Heptane was the object of a series of systematic investigations by EDGAR, SMYTH, PARKS, KHARASCH and their collaborators and by SHEPARD and HENNE; the results agree with those of the B. E. and of BRUYLANTS.

**Constants:** B.E. (1935). — **Polyphasic equilibria**

*Critical constants*

| t° cr | p cr mm | d cr | |
|---|---|---|---|
| 267.01 | 20520 | 0.241 | SMYTH, BEATTIE and KAY (1937) |
| 266.85 | 20430 | 0.2341 | YOUNG (1898–1900–1910) |

N.B. The sample of EDGAR and CALINGAERT (1929) seems pure but the values disagree.

*Densities of the liquid and the saturated vapour:* YOUNG (1910)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.70048 | 0.00007 | 100 | 0.6124 | 0.003597 |
| 10 | 0.6920 | 0.00010 | 110 | 0.6027 | 0.004706 |
| 20 | 0.6836 | 0.00020 | 120 | 0.5926 | 0.006075 |
| 30 | 0.6751 | 0.0003 | 130 | 0.5821 | 0.007764 |
| 40 | 0.6665 | 0.0005 | 140 | 0.5711 | 0.009785 |
| 50 | 0.6579 | 0.0007 | 150 | 0.5598 | 0.01222 |
| 60 | 0.6491 | 0.0011 | 160 | 0.5481 | 0.01511 |
| 70 | 0.6402 | 0.001460 | 170 | 0.5359 | 0.01848 |
| 80 | 0.6311 | 0.002000 | 180 | 0.5232 | 0.02242 |
| 90 | 0.6218 | 0.002703 | 190 | 0.5066 | 0.02711 |

*Densities of the liquid and the saturated vapour:* YOUNG (1910) (continued)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 200 | 0.4952 | 0.03304 | 260 | 0.3457 | 0.1287 |
| 210 | 0.4793 | 0.04005 | 262 | 0.3332 | 0.1397 |
| 220 | 0.4616 | 0.04892 | 264 | 0.3166 | 0.1538 |
| 230 | 0.4414 | 0.06002 | 265 | 0.3059 | 0.1631 |
| 240 | 0.4177 | 0.07446 | 266 | 0.2907 | 0.1778 |
| 250 | 0.3877 | 0.09461 | 266.5 | 0.2819 | 0.1895 |
| 256 | 0.3664 | 0.1117 | 266.56 | 0.2341 | 0.2341 |

*Rectilinear diameter:* $0.3504 + 0.0004192\,t° - 0.0000000621\,t°^2$ YOUNG (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −40.1 | 0.763 | −52.4 | 0.259 | −58.4 | 0.150 | MÜNDEL (1913) |
| −42.6 | 0.632 | −56.4 | 0.179 | −62.7 | 0.096 | ,, |
| −46.7 | 0.440 | | | | | ,, |
| 0 | 11.45 | 100 | 795.2 | 200 | 7261 | YOUNG (1910) |
| 10 | 20.50 | 110 | 1047 | 210 | 8594 | ,, |
| 20 | 35.50 | 120 | 1367 | 220 | 10105 | ,, |
| 30 | 58.35 | 130 | 1753 | 230 | 11810 | ,, |
| 40 | 92.05 | 140 | 2229 | 240 | 13790 | ,, |
| 50 | 140.9 | 150 | 2784 | 250 | 15980 | ,, |
| 60 | 208.9 | 160 | 3450 | 260 | 18470 | ,, |
| 70 | 302.3 | 170 | 4212 | 264 | 19610 | ,, |
| 80 | 426.6 | 180 | 5091 | 266.85 | 20430 | ,, |
| 90 | 588.8 | 190 | 6095 | | | ,, |
| 22.7 | 41.4 | 50.0 | 141.0 | 70.0 | 301.4 | SMYTH and ENGEL (1929) |
| 30.0 | 58.2 | 51.2 | 150.0 | 79.5 | 419.7 | ,, |
| 30.3 | 58.8 | 61.2 | 220.0 | 98.4 | 760 | ,, |
| 38.4 | 86.0 | 69.5 | 297.8 | | | ,, |
| 40.009 | 92.52 | 74.489 | 355.22 | 104.530 | 906.06 | SMITH (1940) |
| 45.637 | 108.06 | 80.402 | 433.56 | 110.681 | 1074.58 | ,, |
| 51.312 | 149.40 | 86.363 | 525.86 | 116.879 | 1268.03 | ,, |
| 57.035 | 187.57 | 92.371 | 633.99 | 123.125 | 1489.14 | ,, |
| 62.806 | 233.72 | 98.427 | 760.00 | 129.418 | 1740.77 | ,, |
| 68.624 | 289.13 | | | | | ,, |
| 25.925 | 47.48 | 51.320 | 149.41 | 92.053 | 627.85 | WILLINGHAM, TAYLOR, |
| 29.699 | 57.49 | 55.394 | 175.84 | 97.154 | 731.99 | PIGNOCCO, and ROSSINI |
| 33.024 | 67.33 | 60.862 | 217.14 | 97.702 | 743.96 | ,, (1945) |
| 36.017 | 77.34 | 65.882 | 261.75 | 98.207 | 755.23 | ,, |
| 38.822 | 87.76 | 71.930 | 324.97 | 98.773 | 768.01 | ,, |
| 42.599 | 103.67 | 78.169 | 402.39 | 99.285 | 779.37 | ,, |
| 46.929 | 124.54 | 84.823 | 500.66 | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 98°35 | B.E. (1935) | 98°40 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| 98°365 | Wojciechowski (1936) | | |
| 98°38 | Shepard, Henne and Midgley (1931) | 98°41 | Appleby, Avery and Meerbott (1947) |
| 98°38 | Mair (1932) | 98°413 | Smith and Matheson (1938) |
| 98°4 | Fawcett (1946) | 98°413 | Wojciechowski (1939) |
| 98°4 | Marschner and Cropper (1946) | 98°422 | Brooks (1938) |
| 98°4 | Lecat (passim) | 98°424 | Brooks, Howard and Crafton (1940) |
| 98°4 | Young (1909–1910) | 98°426 | Forziati, Glascow Jr., Willingham and Rossini (1946) |
| 98°4 | Edgar, Calingaert and Marker (1929) | 98°427 | Smith (1940) |
| 98°4 | Bromiley and Quiggle (1933) | 98°43 | Davies and Gilbert (1941) |
| 98°4 | Smyth and Engel (1929) | 98°43 | Thorpe (1880) |
| 98°4 | Cummings, Stone and Volante (1933) | 98°49 | de Bruyne, Davis and Gross (1933) |
| 98°4 | Hicks-Bruun and Bruun (1932) | 98°5 | Mc Ardle and Robertson (1942) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°4480 | Forziati, Glascow Jr., Willingham and Rossini (1946) | 0°45 | Shepard, Henne and Midgley (1931) |
| 0°448 | Wojciechowski (1936–1939) | 0°45 | Young (1902–1910) |
| 0°4485 | Smith and Matheson (1938) | 0°45 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| 0°4493 | Brooks (1938) | | |
| 0°45 | B.E. (1935) and Lecat (passim) | | |

*Melting point*

| | | | |
|---|---|---|---|
| −90°5 | Smyth and Engel (1929) | −90°64 | Hicks-Bruun and Bruun (1932) |
| −90°5 | Edgar, Calingaert, and Marker (1929) | −90°65 | Appleby, Avery and Meerbott (1947) |
| −90°576 | Brooks (1938) | −90°65 | Shepard, Henne and Midgley (1931) |
| −90°595 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −90°8 | Bromiley and Quiggle (1933) |
| −90°6 | Marschner and Cropper (1946) | −90°8 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| −90°60 | Brooks, Howard and Crafton (1940) | −90°9 | Parks, Huffman and Thomas (1930) |
| −90°609 | Forziati, Glascow Jr., Willingham and Rossini (1946) | | |
| −90°623 | Mair (1932) | | |

*Critical solution point* in $C_6H_5NH_2$

| | | | |
|---|---|---|---|
| 69°9 | Shepard, Henne and Midgley (1931) | 70°0 | Hicks-Bruun and Bruun (1932) |
| 70°0 | Edgar, Calingaert and Marker (1929) | 70°1 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |

*Isotherms:* Young (1910) and Smyth, Beattie and Kay (1937)

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.70048 | B.E. (1935) | 20 | 0.68376 | Smyth and Engel (1929) |
| 15 | 0.68785 | „ | 20 | 0.6838 | Mathews (1926) |
| 30 | 0.67522 | „ | 20 | 0.6838 | Appleby, Avery and Meerbott (1947) |
| 0 | 0.70048 | Young (1910 | | | |
| 10 | 0.6920 | „ | 20 | 0.6839 | Waterman and de Kok (1933) |
| 15 | 0.6878 | „ | | | |
| 20 | 0.6836 | „ | 20 | 0.6839 | Bromiley and Quiggle (1933) |
| 30 | 0.6731 | „ | | | |
| 0 | 0.7005 | Thorpe (1880) | 30 | 0.67520 | de Bruyne, Davis and Gross (1933) |
| 14.9 | 0.68796 | „ | | | |
| 20 | 0.6836 | „ | 0 | 0.7004 | Smyth and Stoops (1928) |
| 20 | 0.68367 | Forziati, etc. (1946) | 10 | 0.6921 | „ |
| 25 | 0.67949 | „ | 20 | 0.6838 | „ |
| 20 | 0.6837 | Quayle, Day and Brown | 0 | 0.70008 | Bruylants (unpubl.) |
| 30 | 0.6752 | „ (1944) | 15 | 0.68793 | „ |
| 40 | 0.6668 | „ | 30 | 0.67538 | „ |
| 50 | 0.6580 | „ | 20 | 0.68378 | Shepard, Henne and Mid- |
| 12.2 | 0.69026 | Perkin (1892) | 25 | 0.67963 | „ gley (1931) |
| 20 | 0.6835 | Fawcett (1946) | 20 | 0.68378 | Wibaut, Hoog, etc. (1939) |
| 20 | 0.6836 | Edgar, Calingaert and | 25 | 0.67954 | „ |
| | | Marker (1929) | 20 | 0.68368 | Brooks, Howard and |
| 20 | 0.68370 | Hicks-Bruun and Bruun | | | Crafton (1940) |
| | | (1932) | 25 | 0.67943 | „ |
| 20 | 0.68372 | Brooks (1938) | 20 | 0.6836 | Grosse and Wackher (1939) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 429 | B.E. (1935) | 0 | 521 | Geist and Cannon (1946) |
| 30 | 364 | „ | 40 | 333 | „ |
| 20 | 409 | Smyth and Stoops (1928) | 20 | 411 | Fawcett (1946) |

*Viscosity* (continued)

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 6.43 | 479.7 | THORPE and RODGER | 62.04 | 271.4 | „ |
| 6.56 | 479.5 | „ (1894) | 70.09 | 252.6 | „ |
| 13.45 | 441.8 | „ | 77.10 | 237.2 | „ |
| 21.74 | 402.7 | „ | 85.49 | 221.8 | „ |
| 30.27 | 368.5 | „ | 92.21 | 209.6 | „ |
| 38.34 | 339.7 | „ | 25 | 385.5 | LEWIS (1922) |
| 47.25 | 311.2 | „ | 25 | 385.9 | SHEPARD, HENNE and MIDGLEY (1931) |
| 55.03 | 289.0 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 0 | 22.19 | THORPE (1879) | 20 | 20.30 | QUAYLE, DAY and BROWN |
| 10 | 21.12 | „ | 30 | 19.29 | „ (1944) |
| 15 | 20.85 | B.E. (1935) | 40 | 18.32 | „ |
| 20 | 20.35 | „ | 50 | 17.20 | „ |
| 30 | 19.27 | „ | 20 | 20.26 | WIBAUT, HOOG, etc. (1939) |
| | | | 20 | 20.28 | EDGAR and CALINGAERT (1929) |

*Refractive index*

| t° | He r. | H$\alpha$ | D | He y. | He g. | H$\beta$ | He v. | H$\gamma$ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.38772 | 1.38806 | 1.39002 | 1.39019 | 1.39398 | 1.39495 | 1.39797 | — | B. E. (1935) |
| $\frac{dn}{dt}$ | 0.00046 | 46 | — | 46 | 47 | 47 | 47 | — | „ |
| 15 | 1.38784 | 1.38808 | 1.39001 | 1.39016 | 1.39389 | 1.39481 | 1.39764 | 1.39864 | BRUYLANTS (unp.) |
| 30 | 1.38090 | 1.38141 | 1.38312 | 1.38314 | 1.38640 | 1.38781 | 1.39066 | 1.39117 | „ |
| $\frac{dn}{dt}$ | 0.00046 | 44 | 46 | 47 | 49 | 47 | 46 | 46 | „ |
| 20 | — | 1.38573 | 1.38775 | — | — | 1.39247 | — | 1.39637 | WIBAUT, etc. (1939) |
| 25 | — | 1.38322 | 1.38521 | — | — | 1.38987 | — | 1.39373 | „ |
| $\frac{dn}{dt}$ | — | 0.00050 | 51 | — | — | 52 | — | 53 | „ |
| 20 | — | — | 1.38764 | — | — | — | — | — | BROOKS, HOWARD and CRAFTON (1940) |
| 25 | — | — | 1.38511 | — | — | — | — | — | |
| $\frac{dn}{dt}$ | — | — | 0.000506 | — | — | — | — | — | |
| 20 | — | — | 1.38764 | — | — | — | — | — | FORZIATI, etc. (1946) |
| 25 | — | — | 1.38517 | — | — | — | — | — | |
| $\frac{dn}{dt}$ | — | — | 0.00049 | — | — | — | — | — | |

*Refractive index* (continued)

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 12,2 | — | 1.38966 | 1.39178 | — | — | 1.39664 | — | — | Perkin (1892) |
| 20 | — | 1.38580 | 1.38775 | — | — | 1.39261 | — | — | Shepard, Henne and Midgley (1931) |
| 20 | — | 1.38579 | 1.38777 | — | — | 1.39248 | — | 1.39646 | Smyth and Stoops (1928) |
| 20 | — | 1.38584 | 1.38777 | — | — | 1.39251 | — | 1.39636 | Dornte and Smyth (1930) |
| 20 | — | — | 1.3876 | — | — | — | — | — | MacArdle and Robertson (1942) |
| 20 | — | — | 1.38763 | — | — | — | — | — | Smyth and MacAlpine (1934) |
| 20 | — | — | 1.38767 | — | — | — | — | — | Smyth and Engel (1929) |
| 20 | — | — | 1.38768 | — | — | — | — | — | Davies and Gilbert (1941) |
| 20 | — | — | 1.3877 | — | — | — | — | — | Hicks-Bruun and Bruun (1932) |
| 20 | — | — | 1.3877 | — | — | — | — | — | Woodburn, Smith and Tetewsky (1944) |
| 20 | — | — | 1.3877 | — | — | — | — | — | Fawcett (1946) |
| 20 | — | — | 1.3977 | — | — | — | — | — | Marschner and Cropper (1946) |
| 20 | — | — | 1.3877 | — | — | — | — | — | Applebey, Avery and Meerbott (1947) |
| 20 | — | — | 1.38771 | — | — | — | — | — | Stearn and Smyth (1934) |
| 20 | — | — | 1.38777 | — | — | — | — | — | Edgar (1923) |
| 20 | — | — | 1.38777 | — | — | — | — | — | Brooks (1938) |
| 20 | — | — | 1.3878 | — | — | — | — | — | Bromiley, etc. (1933) |
| 25 | — | — | 1.38510 | — | — | — | — | — | Mair (1932) |
| 30 | — | — | 1.38292 | — | — | — | — | — | de Bruyne, etc. (1933) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −183.06 | 0.205 | −127.86 | 0.287 | +2.24 | 0.513 | Parks, Huffman and Thomas (1930) |
| −182.56 | 0.206 | −122.26 | 0.295 | 2.84 | 0.514 | |
| −177.16 | 0.216 | L. −85.16 | 0.480 | 6.34 | 0.517 | ,, |
| −170.56 | 0.226 | −73.16 | 0.480 | 14.34 | 0.522 | ,, |
| −163.56 | 0.236 | −55.76 | 0.484 | 18.14 | 0.525 | ,, |
| −150.96 | 0.254 | −37.36 | 0.489 | 21.04 | 0.527 | ,, |
| −144.66 | 0.263 | −32.76 | 0.491 | 26.04 | 0.530 | ,, |
| −138.56 | 0.271 | −15.16 | 0.500 | | | ,, |
| −132.66 | 0.280 | −10.66 | 0.504 | | | ,, |

*Specific heat of the vapour:* Waddington, Todd and Huffman (1947)

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 90·48 | 76.997 cal 15°/g | Waddington, Todd and Huffman |
| | 77°33 | 79.223 „ | „ (1947) |
| | 58°06 | 82.277 „ | „ |
| | 25° | 87.175 „ | Osborne and Ginnings (1947) |
| *Heat of melting* | | 33.78 „ | Parks, Huffman and Thomas (1930) |
| *Heat of combustion* | 30° | ($c_p$) 11479.3 „ | Jessup (1937) (M. W. 100.1926) |
| | 25° | ($c_p$) 11485.7 „ | „ |
| | 25° | ($c_p$) 11493.4 „ | Davies and Gilbert (1941) |
| | 25° | ($c_p$) 11490.5 „ | Prosen and Rossini (1944) (M. W. 100.198) |

## ISOMERIC HEPTANES

Their synthesis in a state of purity has been carried out by Chavanne and his collaborators, and also by Edgar, Calingaert and Marker, whose samples were used for other measurements by Edgar, Smyth, Huffman and Kharasch.

Usual method of preparation: Action of ketones, aldehydes or esters on Grignard's reagent in order to obtain a secondary alcohol, which is submitted to dehydration followed by catalytic hydrogenation.

### 2-METHYLHEXANE $CH_3-CH(CH_3)-(CH_2)_3-CH_3$

Obtained by extraction from petroleum: Bruun and Hicks-Bruun (1933)

**Constants**

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 257.9 | 27.2 | Edgar and Calingaert (1929) |

*Boiling point*

| | | | |
|---|---|---|---|
| 89·67 | Bruun and Hicks-Bruun (1933) | 90·08 | Davies and Gilbert (1941) |
| 90·0 | Edgar, Calingaert and Marker (1929) | 90·10 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |

*Freezing point*

| | | | |
|---|---|---|---|
| −118°2 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg, (1939) | −119°1 | Edgar, Calingaert and Marker (1929) |
| −118°9 | Bruun and Hicks-Bruun (1933) | −119°1 | Parks, Huffman and Thomas (1930) |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 73°6 | Wibaut, Hoog, etc. (1939) |
| | 74°1 | Edgar, Calingaert and Marker (1929) |
| | 74°1 | Bruun and Hicks-Bruun (1933) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 0.6789 | Edgar, Calingaert and Mar- | 20 | 0.67869 | Wibaut, Hoog, etc. (1939) |
| 25 | 0.6746 | „ ker (1929) | 25 | 0.67437 | „ |
| 25 | 0.67492 | Bruun and Hicks-Bruun (1933) | | | |

*Viscosity:* 20° $378 \cdot 10^{-5}$ Smyth and Stoops (1928)

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 19.17 | Wibaut, Hoog, etc. (1939) |
| 20 | 19.37 | Edgar, Calingaert and Marker (1929) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.38311 | 1.38509 | 1.38983 | 1.39377 | Smyth and Stoops (1928) |
| 20 | 1.38292 | 1.38498 | 1.38967 | 1.39355 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.38041 | 1.38240 | 1.38702 | 1.39091 | „ |
| $\frac{dn}{dt}$ | 0.00050 | 51 | 53 | 53 | „ |
| 20 | — | 1.3850 | — | — | Bruun and Hicks-Bruun (1933) |
| 20 | — | 1.38478 | — | — | Davies and Gilbert (1941) |

*Dielectric constant:* 20° 1.922 Smyth and Stoops (1928)

*Specific heat:* PARKS, HUFFMAN and THOMAS (1930)

| | t° | $c_p$ | t° | $c_p$ | | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|---|---|
| C. | −187.26 | 0.202 | −165.76 | 0.237 | L. | −112.96 | 0.427 | −32.86 | 0.480 |
| | −185.56 | 0.206 | −164.56 | 0.239 | | −107.16 | 0.430 | −17.76 | 0.491 |
| | −183.36 | 0.212 | −158.76 | 0.249 | | − 92.86 | 0.439 | + 2.64 | 0.507 |
| | −180.66 | 0.217 | −157.66 | 0.250 | | − 77.96 | 0.449 | 13.04 | 0.519 |
| | −179.06 | 0.219 | −150.36 | 0.262 | | − 62.16 | 0.460 | 19.24 | 0.523 |
| | −171.76 | 0.229 | | | | − 48.16 | 0.469 | | |

| | | |
|---|---|---|
| *Heat of melting* | 21.16 cal 15°/g | PARKS, HUFFMAN and THOMAS (1930) |
| *Heat of combustion* | 25° ($c_p$) 11480.8 „ | DAVIES and GILBERT (1941) |

## 3-METHYLHEXANE $CH_3-CH_2-CH(CH_3)-(CH_2)_2-CH_3$

### Constants

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 262.4 | 28.1 | EDGAR and CALINGAERT (1929) |

*Boiling point*

| | | | |
|---|---|---|---|
| 91°8 | EDGAR, CALINGAERT and MARKER (1929) | 91°8 | BOCHAROV and OBOLENZEV (1946) |
| 91°8 | DE GRAEF (1925) | 91°96 | DAVIES and GILBERT (1941) |
| 91°879 | $\frac{dt}{dp}$ *(10 mm):* 0°445 WOJCIECHOWSKI (1939) | | |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 70°5 | EDGAR, CALINGAERT and MARKER (1929) |
| | 70°5 | DE GRAEF (1925) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.6909 | De Graef (1925) | 20 | 0.6870 | Edgar, Calingaert and Marker (1929) |
| 20 | 0.6868 | „ | 20 | 0.6870 | Botcharov and Obolenzev (1946) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 386 | De Graef (1925) |
| 30 | 329 | „ |
| 20 | 372 | Smyth and Stoops (1928) |

*Surface tension:* 20° 19.56 Edgar and Calingaert (1929)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.38677 | 1.38873 | 1.39343 | 1.39744 | Smyth and Stoops (1928) |
| 20 | — | 1.38857 | — | — | Davies and Gilbert (1941) |
| 20 | — | 1.3888 | — | — | Botcharov and Obolenzev (1946) |
| 20.4 | 1.3865 | 1.3884 | 1.3932 | — | De Graef (1925) |

*Dielectric constant:* 20° 1.930 Smyth and Stoops (1928)

*Specific heat:* Huffman, Parks and Thomas (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −202.06 | 0.178 | L. −182.16 | 0.395 | −121.36 | 0.415 | Huffman, Parks and Thomas (1930) |
| −198.46 | 0.187 | −180.36 | 0.397 | − 99.36 | 0.426 | „ |
| −195.16 | 0.197 | −178.06 | 0.398 | − 77.46 | 0.440 | „ |
| −192.06 | 0.205 | −174.06 | 0.398 | − 53.36 | 0.457 | „ |
| −189.16 | 0.215 | −166.86 | 0.400 | − 30.06 | 0.472 | „ |
| | | −154.26 | 0.403 | + 2.64 | 0.498 | „ |
| | | −141.76 | 0.407 | 16.04 | 0.511 | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 11488.1 cal 15°/g | Davies and Gilbert (1941) |

## 3-ETHYLPENTANE or TRIETHYLMETHANE $C_2H_5-CH(C_2H_5)-C_2H_5$

### Constants

*Saturated vapour pressure:* SMITH (1941)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 35.127 | 92.52 | 52.113 | 187.57 | 75.449 | 433.56 | 105.726 | 1074.58 |
| 40.740 | 118.06 | 57.873 | 233.72 | 81.406 | 525.86 | 111.929 | 1268.03 |
| 46.402 | 149.40 | 63.682 | 289.13 | 87.412 | 633.99 | 118.182 | 1489.14 |
| | | 69.541 | 355.22 | 99.572 | 906.06 | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 93°368 | WOJCIECHOWSKI (1939) | 93°468 | SMITH (1940) |
| 93°37 | DAVIES and GILBERT (1941) | 93°473 | BROOKS, HOWARD and CRAFTON (1940) |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°446 | BROOKS, HOWARD and CRAFTON (1940) | 0°448 | WOJCIECHOWSKI (1939) |

*Freezing point*

| | | | |
|---|---|---|---|
| −118°605 | STREIFF, MURPHY, SEDLAK, WILLINGHAM and ROSSINI (1946) | −118°8 | HUFFMAN, PARKS and THOMAS (1930) |
| −118°65 | BROOKS, HOWARD and CRAFTON (1940) | | |

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.69818 | Brooks, Howard and Crafton (1940) |
| 25 | 0.69377 | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | — | 1.39327 | — | — | Davies and Gilbert (1941) |
| 20 | — | 1.39337 | — | — | Brooks, Howard and Crafton (1940) |
| 25 | — | 1.39084 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00051 | — | — | „ |

*Specific heat:* Huffman, Parks and Thomas (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −180.96 | 0.206 | −154.26 | 0.248 | L. −111.76 | 0.416 | −14.66 | 0.486 |
| −174.86 | 0.216 | −147.96 | 0.259 | −106.36 | 0.419 | − 3.24 | 0.499 |
| −168.16 | 0.227 | −141.76 | 0.269 | − 92.76 | 0.427 | + 9.04 | 0.505 |
| −161.06 | 0.238 | −135.96 | 0.282 | − 72.96 | 0.442 | 14.34 | 0.510 |
| | | | | − 35.66 | 0.470 | 21.64 | 0.519 |

| | | |
|---|---|---|
| *Heat of melting* | 22.56 cal 15°/g | Huffman, Parks and Thomas (1930) |
| *Heat of combustion* | 25° ($c_p$) 11491.3 „ | Davies and Gilbert (1941) |

## 2,2-DIMETHYLPENTANE $(CH_3)_3C-(CH_2)_2-CH_3$

*Methods of preparation*

1°) by the action of sodium on a mixture of *n*-propyl bromide and *tertiary* butyl chloride.

2°) by chlorination of pinacolin, transformation into *pseudo*-butylacetylene, then into *tertiary* methylbutylacetylene by the action of dimethyl sulphate, and catalytic hydrogenation of the compound obtained.

3°) by dehydration, followed by catalytic hydrogenation, of 2,2-dimethylpentanol-3 obtained by the reaction of propionic aldehyde on *tert.* butyl chloride.

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 15.325 | 67.27 | 53.261 | 402.46 | Willingham, Taylor, Pignocco and Rossini |
| 18.253 | 77.31 | 59.362 | 500.72 | „ (1945) |
| 20.979 | 87.74 | 65.879 | 627.94 | „ |
| 24.670 | 103.68 | 72.945 | 627.70 | „ |
| 28.879 | 124.68 | 77.958 | 732.11 | „ |
| 33.160 | 149.46 | 78.496 | 744.07 | „ |
| 37.129 | 175.94 | 78.995 | 755.28 | „ |
| 42.454 | 217.21 | 79.550 | 768.04 | „ |
| 47.359 | 324.99 | 80.050 | 779.35 | „ |
| 80 | 775.20 | 160 | 5092.0 | Fawcett (1946) |
| 100 | 1352.80 | 180 | 7334.0 | „ |
| 120 | 2211.60 | 200 | 10184.0 | „ |
| 140 | 3435.20 | 210 | 11932.0 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 79°2 | Fawcett (1946) | 79°210 | Wojciechowski (1939) |
| 79°201 | Willingham, Taylor, etc (1945) | 79°25 | Davies and Gilbert (1941) |
| 79°203 | Forziati, Glasgow Jr., Willingham and Rossini (1946) | 79°3 | De Graef (1925) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°436 | Willingham, Taylor, etc. (1945) | 0°4394 | Forziati, Glasgow Jr., etc. (1946) |
| 0°439 | Wojciechowski (1939) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −123°794 | Forziati, Glasgow Jr., etc. (1946) | −125°0 | Huffman, Parks and Thomas (1930) |
| −124°0 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) | | |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 77°7 | De Graef (1925) |
| | 77°7 | Edgar, Calingaert and Marker (1929) |
| | 78°3 | Wibaut, Hoog, etc. (1939) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.6908 | Smyth and Stoops (1928) | 20 | 0.67388 | Wibaut, Hoog, etc. (1939) |
| 10 | 0.6823 | „ | 25 | 0.66953 | „ |
| 20 | 0.6738 | „ | 20 | 0.67385 | Forziati, Glasgow Jr., etc. |
| 30 | 0.6652 | „ | 25 | 0.66958 | „ (1946) |
| 15 | 0.6780 | De Graef (1925) | 20 | 0.6736 | Fawcett (1946) |
| 20 | 0.6738 | „ | 20 | 0.6737 | Edgar, Calingaert and Marker (1929) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 401 | De Graef (1925) |
| 30 | 340 | „ |
| 20 | 385 | Smyth and Stoops (1928) |

*Surface tension:* 20° 18.05 Wibaut, Hoog, etc. (1939)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.38038 | 1.38233 | 1.38710 | 1.39106 | Smyth and Stoops (1928) |
| 20.6 | 1.3799 | 1.3820 | 1.3866 | — | De Graef (1925) |
| 20 | 1.38025 | 1.38226 | 1.38703 | 1.39092 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.37763 | 1.37964 | 1.38429 | 1.38821 | „ |
| $\frac{dn}{dt}$ | 0.00052 | 52 | 55 | 54 | „ |
| 20 | — | 1.38217 | — | — | Forziati, Glasgow Jr., etc. (1946) |
| 25 | — | 1.37955 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00052 | — | — | „ |
| 20 | — | 1.38209 | — | — | Davies and Gilbert (1941) |
| 20 | — | 1.3824 | — | — | Fawcett (1946) |

*Specific heat:* Huffman, Parks and Thomas (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −181.26 | 0.200 | L. −119.96 | 0.388 | −35.76 | 0.461 |
| −175.26 | 0.210 | −118.86 | 0.389 | −16.36 | 0.478 |
| −169.86 | 0.219 | −110.96 | 0.395 | + 1.94 | 0.498 |
| −161.96 | 0.234 | − 95.66 | 0.407 | 7.14 | 0.505 |
| −154.76 | 0.244 | − 87.06 | 0.415 | 14.04 | 0.511 |
| | | − 73.36 | 0.428 | 20.94 | 0.518 |
| | | − 57.36 | 0.442 | | |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 77.343 cal 15°/g | Osborne and Ginnings (1947) |
| *Heat of melting* | | 13.98 „ | Huffman, Parks and Thomas (1930) |
| *Heat of combustion* | 25° ($c_p$) | 11454.3 „ | Davies and Gilbert (1941) |

## 2.3-DIMETHYLPENTANE or METHYLETHYL *iso*-PROPYLMETHANE

$(CH_3)_2-CH-CH(CH_3)-CH_2-CH_3$

### Constants

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 264.6 | 29.2 | Edgar and Calingaert (1929) |

*Boiling point*

| | | | |
|---|---|---|---|
| 89°7 | Edgar, Calingaert and Marker (1929) | 89°78 | Davies and Gilbert (1941) |
| | | 90° | Chavanne and De Graef (1924) |

89°787 $\frac{dt}{dp}$ *(10 mm):* 0°450 Howard, Mears, Fookson, Pomerantz and Brooks (1947)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 68°0 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| | 68°1 | Chavanne and De Graef (1924) |
| | 68°1 | Edgar, Calingaert and Marker (1929) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.7117 | Chavanne and De Graef | 20 | 0.69514 | Wibaut, Hoog, etc. (1939) |
| 15 | 0.6991 | „ (1924) | 25 | 0.69087 | „ |
| 20 | 0.6950 | „ | 20 | 0.69510 | Howard, Mears, Fookson, Pomerantz and Brooks |
| 20 | 0.6952 | Edgar, Calingaert and Marker (1929) | 25 | 0.69090 | „ (1947) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 436 | Chavanne and De Graef (1924) |
| 30 | 412 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 19.65 | Edgar and Calingaert (1929) |
| 20 | 19.82 | Wibaut, Hoog, etc. (1939) |

*Dielectric constant:* 20° 1.942 Smyth and Stoops (1928)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.3894 | 1.3918 | 1.3965 | 1.4002 | Chavanne and De Graef (1924) |
| 20 | 1.39005 | 1.39201 | 1.39675 | 1.40071 | Smyth and Stoops (1928) |
| 20 | 1.39007 | 1.39210 | 1.39680 | 1.40074 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.38753 | 1.38957 | 1.39422 | 1.39811 | „ |
| $\frac{dn}{dt}$ | 0.00051 | 51 | 52 | 53 | „ |
| 20 | — | 1.39193 | — | — | Howard, Mears, etc. (1947) |
| 25 | — | 1.38950 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00049 | — | — | „ |
| 20 | — | 1.39202 | — | — | Davies and Gilbert (1941) |

*Specific heat:* Huffman, Parks and Thomas (1930)

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|---|
| Gl. | −204.76 | 0.169 | −183.96 | 0.376 | −145.16 | 0.389 | −62.36 | 0.442 |
| | −200.36 | 0.177 | −182.76 | 0.374 | −139.26 | 0.393 | −39.16 | 0.459 |
| | −196.36 | 0.189 | −181.06 | 0.374 | −112.86 | 0.409 | −33.06 | 0.465 |
| | −192.46 | 0.205 | −178.96 | 0.376 | − 91.66 | 0.421 | + 4.04 | 0.496 |
| | | | −168.46 | 0.380 | − 68.16 | 0.437 | 18.14 | 0.510 |
| L. | −186.36 | 0.377 | −161.86 | 0.383 | | | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | 25° 81.667 cal 15° g | Osborne and Ginnings (1947) |
| *Heat of combustion* | 25° ($c_p$) 11476.2 „ | Davies and Gilbert (1941) |

## 2.4-DIMETHYLPENTANE or DI *iso*-PROPYLMETHANE

$(CH_3)_2CH-CH_2-CH(CH_3)_2$

Prepared by the action of ethyl isovalerate on methylmagnesium iodide.

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 80·49 | Davies and Gilbert (1941) | 80·60 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| 80·508 | Howard, Mears, Fookson, Pomerantz and Brooks (1947) | 80°8 | Chavanne and De Graef (1924) |
| | | 80°8 | Marschner and Cropper (1946) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°42 | WIBAUT, HOOG, etc. (1939) | 0°431 | HOWARD, MEARS, etc. (1947) |

*Freezing point*

| | | | |
|---|---|---|---|
| −119°1 | WIBAUT, HOOG, etc. (1939) | −120°4 | RICHARDS and HARGREAVES (1944) |
| −119°2 | TIMMERMANS (passim) | | |
| −119°265 | STREIFF, MURPHY, SEDLAK, WILLINGHAM and ROSSINI (1946) | −120°6 | MARSCHNER and CROPPER (1946) |
| | | −120°6 | HUFFMAN, PARKS and THOMAS (1930) |
| −119°86 | HOWARD, MEARS, etc. (1947) | | |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 78°6 | CHAVANNE and DE GRAEF (1924) |
| | 78°7 | WIBAUT, HOOG, etc. (1939) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.6899 | CHAVANNE and DE GRAEF | 20 | 0.67275 | WIBAUT, HOOG, etc. (1939) |
| 15 | 0.6769 | „ (1924) | 25 | 0.66837 | „ |
| 20 | 0.6731 | „ | 20 | 0.67315 | HOWARD, MEARS, etc. (1947) |
| | | | 25 | 0.66879 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 375 | CHAVANNE and DE GRAEF (1924) |
| 20 | 360 | „ |

*Surface tension:* 20° 18.12 WIBAUT, HOOG, etc. (1939)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.3795 | 1.3814 | 1.3862 | 1.3900 | CHAVANNE and DE GRAEF (1924) |
| 20 | 1.37956 | 1.38153 | 1.38620 | 1.39012 | WIBAUT, HOOG, etc. (1939) |
| 25 | 1.37697 | 1.37892 | 1.38357 | 1.38745 | „ |
| $\frac{dn}{dt}$ | 0.00052 | 52 | 53 | 53 | „ |
| 20 | — | 1.38165 | — | — | HOWARD, MEARS, etc. (1947) |
| 25 | — | 1.37903 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00052 | — | — | „ |
| 20 | — | 1.38167 | — | — | DAVIES and GILBERT (1941) |
| 20 | — | 1.3817 | — | — | MARSCHNER and CROPPER (1946) |

*Specific heat:* Huffman, Parks and Thomas (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −181.56 | 0.201 | L. −112.96 | 0.400 | −67.46 | 0.440 | −11.76 | 0.495 |
| −178.06 | 0.209 | −111.96 | 0.402 | −57.86 | 0.449 | + 2.24 | 0.505 |
| −175.76 | 0.212 | −101.46 | 0.410 | −47.46 | 0.458 | 8.34 | 0.512 |
| −168.96 | 0.223 | − 91.76 | 0.417 | −36.76 | 0.468 | 15.04 | 0.519 |
| −161.56 | 0.237 | − 76.86 | 0.430 | −30.76 | 0.472 | 21.24 | 0.529 |
| −153.16 | 0.254 | | | | | | |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 78.448 cal 15° g | Osborne and Ginnings (1947) |
| *Heat of melting* | | 15.95 „ | Huffman, Parks and Thomas (1930) |
| *Heat of combustion* | 25° ($c_p$) | 11463.4 „ | Davies and Gilbert (1941) |

## 3.3-DIMETHYLPENTANE or DIMETHYLDIETHYLMETHANE

$CH_3-CH_2-C(CH_3)_2-CH_2-CH_3$

Prepared by the action of ethyl bromide on *tert.* amyl bromide (Würtz) or by the action of zinc diethyl on 1,1-dimethyl-1-iodopropane.

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 85°97 | Davies and Gilbert (1941) | 86°0 | Edgar, Calingaert and Marker (1929) |
| 86°10 | $\frac{dt}{dp}$ *(10 mm)*: 0·44 Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −134·9 | Huffman, Parks and Thomas (1930) | −135° | Edgar, Calingaert and Marker (1929) |
| | | −135°7 | Wibaut, Hoog, etc. (1939) |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 69°7 | Wibaut, Hoog, etc. (1939) |
| | 71°0 | Edgar, Calingaert and Marker (1929) |

*Viscosity:* 20° $454 \cdot 10^{-5}$ Smyth and Stoops (1928)

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.6934 | Edgar, Calingaert and Marker (1929) |
| 20 | 0.69330 | Wibaut, Hoog, etc. (1939) |
| 25 | 0.68911 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 19.44 | Wibaut, Hoog, etc. (1939) |
| 20 | 19.63 | Edgar and Calingaert (1929) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.38918 | 1.39114 | 1.39589 | 1.39987 | Smyth and Stoops (1928) |
| 20 | 1.38901 | 1.39097 | 1.39575 | 1.39964 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.38652 | 1.38853 | 1.39322 | 1.39715 | „ |
| $\frac{dn}{dt}$ | 0.00050 | 49 | 50 | 50 | „ |
| 20 | — | 1.39094 | — | — | Davies and Gilbert (1941) |
| 20 | — | 1.39114 | — | — | Edgar, Calingaert and Marker (1929) |

*Dielectric constant:* 20° 1.940 Smyth and Stoops (1928)

*Specific heat:* Huffman, Parks and Thomas (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −180.86 | 0.192 | L. −127.46 | 0.392 | −77.66 | 0.421 | + 1.94 | 0.486 |
| −175.66 | 0.201 | −121.76 | 0.395 | −62.66 | 0.432 | 6.14 | 0.492 |
| −169.46 | 0.212 | −112.46 | 0.400 | −47.46 | 0.444 | 13.34 | 0.498 |
| −164.46 | 0.223 | −101.26 | 0.405 | −33.26 | 0.456 | 18.74 | 0.505 |
| −159.16 | 0.233 | − 90.16 | 0.412 | −20.46 | 0.466 | | |
| −154.96 | 0.243 | | | | | | |
| −150.16 | 0.254 | | | | | | |

| | | |
|---|---|---|
| *Heat of melting* | 16.86 cal 15°/g | Huffman, Parks and Thomas (1930) |
| *Heat of combustion* | 25° ($c_p$) 11463.1 „ | Davies and Gilbert (1941) |

## 2.2.3-TRIMETHYLBUTANE or TRIMETHYL *iso*-PROPYLMETHANE

$(CH_3)_3C-CH(CH_3)_2$

Prepared by the action of pinacolin on methylmagnesium iodide.

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 258.3 | 29.75 | Edgar and Calingaert (1929) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 22.696 | 92.52 | 51.122 | 289.13 | 80.872 | 760.00 | Smith (1940) |
| 28.275 | 118.06 | 56.966 | 355.22 | 86.981 | 906.06 | „ |
| 33.907 | 149.40 | 62.863 | 453.56 | 93.142 | 1074.58 | „ |
| 39.593 | 187.57 | 68.813 | 525.86 | 99.357 | 1268.03 | „ |
| 45.331 | 233.72 | 74.816 | 630.99 | 105.625 | 1489.14 | „ |
| 80.9 | 760 | 90.6 | 1000 | 103.2 | 1400 | Fawcett (1946) |
| 82.6 | 800 | 97.3 | 1200 | 108.6 | 1600 | „ |
| 86.8 | 900 | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 80°75 | Chavanne and Van Risseghem (1922) | 80°89 | Davies and Gilbert (1941) |
| 80°8 | Harrison and Berg (1946) | 80°9 | Edgar, Calingaert and Marker (1929) |
| 80°872 | Smith (1940) | 80°9 | Fawcett (1946) |
| 80°879 | Brooks, Howard and Crafton (1940) | | |

$\frac{dt}{dp}$ *(10 mm)*

| | |
|---|---|
| 0°449 | Brooks, Howard and Crafton (1940) |

*Freezing point*

| | | | |
|---|---|---|---|
| −24°96 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −25°059 | Brooks, Howard and Crafton (1940) |
| −25° | Edgar, Calingaert and Marker (1929) | −25°4 | Huffman, Parks and Thomas (1930) |
| −25° | Timmermans (passim) | | |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 72°2 | Wibaut, Hoog, etc. (1939) |
| | 72°4 | Edgar, Calingaert and Marker (1929) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.7065 | Chavanne and Van Risseghem (1922) | 20 | 0.69000 | Brooks, Howard and Crafton (1940) |
| 15 | 0.6945 | „ | 25 | 0.68576 | „ |
| 20 | 0.69007 | Wibaut, Hoog, etc. (1939) | 20 | 0.6896 | Fawcett (1946) |
| 25 | 0.68583 | „ | 20 | 0.6900 | Edgar, Calingaert and Marker (1929) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 20 | 579 | Fawcett (1946) |
| 20 | 585 | Smyth and Stoops (1928) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 18.60 | Edgar and Calingaert (1929) |
| 20 | 18.86 | Wibaut, Hoog, etc. (1939) |

*Dielectric constant:* 20° 1.930 Smyth and Stoops (1928)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.3903 | 1.3923 | 1.3971 | 1.4008 | Chavanne and Lejeune (1922) |
| 20 | 1.38744 | 1.38940 | 1.39419 | 1.39817 | Smyth and Stoops (1928) |
| 20 | 1.38751 | 1.38954 | 1.39430 | 1.39822 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.38494 | 1.38695 | 1.39168 | 1.39561 | „ |
| $\frac{dn}{dt}$ | 0.00051 | 52 | 52 | 52 | „ |
| 20 | — | 1.38947 | — | — | Brooks, Howard and Crafton (1940) |
| 25 | — | 1.38683 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00053 | — | — | „ |
| 20 | — | 1.3891 | — | — | Marschner and Cropper (1946) |
| 20 | — | 1.3893 | — | — | Harrison and Berg (1946) |
| 20 | — | 1.3894 | — | — | Mac Ardle and Robertson (1944) |
| 20 | — | 1.3894 | — | — | Fawcett (1946) |
| 20 | — | 1.38943 | — | — | Davies and Gilbert (1941) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. I. −183.66 | 0.212 | C. II. −62.46 | 0.409 | Huffman, Parks and Thomas |
| −180.96 | 0.222 | −51.16 | 0.422 | „ (1930) |
| −178.36 | 0.232 | −42.66 | 0.431 | „ |
| −156.86 | 0.310 | −39.56 | 0.435 | „ |
| −143.56 | 0.321 | −36.96 | 0.439 | „ |
| −141.96 | 0.324 | | | „ |
| −136.26 | 0.329 | L. −19.96 | 0.459 | „ |
| −124.66 | 0.341 | −14.66 | 0.463 | „ |
| −111.36 | 0.354 | + 2.54 | 0.479 | „ |
| − 98.36 | 0.366 | 8.44 | 0.485 | „ |
| − 74.06 | 0.380 | 20.74 | 0.497 | „ |

*Specific heat of the vapour:* Waddington, Todd and Huffman (1947)

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 76.423 cal 15°/g | Osborne and Ginnings (1947) |
| | 80°80 | 69.04 „ | Waddington, Todd and Huffman |
| | 40°68 | 74.46 „ | „ (1947) |
| *Heat of melting* | | 5.25 „ | Huffman, Parks and Thomas (1930) |
| *Heat of combustion* | 25° ($c_p$) | 11465.3 „ | Davies and Gilbert (1941) |
| | 25° ($c_p$) | 11449.53 „ | Coops, Mulder, Dienske and Smittenberg (1946) (M. W. 100.198) |

## *n*-OCTANE $n\text{-}C_8H_{18}$

*Methods of preparation*

1°) From *n*-butyl bromide (WÜRTZ's reaction) B.E. (1928)

2°) Reduction of octyl iodide (YOUNG, 1900)

3°) By fractionation of petroleum ether after previous treatment with chlorosulphonic acid (SHEPARD, HENNE and MIDGLEY, 1931).
This sample has been used by SMYTH, HUFFMAN and KHARASCH for their determinations.

**Constants:** B.E. (1928)

The published values (B.E., 1928) of the density and the refractive index have been corrected in the light of new experiments and agree with those of BRUYLANTS.

MAMAN (1937—38) has studied a series of octanes, but when a comparison is possible, his results do not agree with those of other authors except for *n*-octane.

**Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 296.2 | 18730 | 0.2327 | YOUNG (1900–10) |

*Rectilinear diameter:* $0.3592 - 0.0003986\ t° - 0.0000000960\ t°^2$ YOUNG (1910) (corr. 1900)

*Densities of the liquid and the saturated vapour:* Young (1910)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.71848 | — | 160 | 0.5772 | 0.008591 |
| 10 | 0.7102 | — | 170 | 0.5667 | 0.01071 |
| 20 | 0.7022 | (0.0001) | 180 | 0.5556 | 0.01316 |
| 30 | 0.6942 | 0.0001 | 190 | 0.5441 | 0.01613 |
| 40 | 0.6860 | 0.0002 | 200 | 0.5317 | 0.01965 |
| 50 | 0.6778 | 0.0003 | 210 | 0.5189 | 0.02364 |
| 60 | 0.6694 | 0.0004 | 220 | 0.5053 | 0.02874 |
| 70 | 0.6611 | 0.0006 | 230 | 0.4901 | 0.03484 |
| 80 | 0.6525 | 0.0009 | 240 | 0.4732 | 0.04237 |
| 90 | 0.6438 | 0.0013 | 250 | 0.4554 | 0.05118 |
| 100 | 0.6351 | 0.0017 | 260 | 0.4364 | 0.06223 |
| 110 | 0.6260 | 0.0023 | 270 | 0.4123 | 0.07716 |
| 120 | 0.6168 | 0.003247 | 280 | 0.3818 | 0.09833 |
| 130 | 0.6071 | 0.004219 | 290 | 0.3365 | 0.1346 |
| 140 | 0.5973 | 0.005405 | 296.2 | 0.2327 | 0.2327 |
| 150 | 0.5875 | 0.006863 | | | |

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| −35.1 | 0.167 | Mündel (1913) | −9.3 | 1.47 | Linder (1931) |
| −30.1 | 0.280 | „ | −3.0 | 2.32 | „ |
| −20.1 | 0.633 | „ | +3.7 | 3.65 | „ |
| −10.1 | 1.384 | „ | | | |

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 0 | 2.94 | 110 | 481.9 | 210 | 4927 | Young (1900–10) |
| 10 | 5.62 | 120 | 646.4 | 220 | 5873 | „ |
| 20 | 10.45 | 130 | 859 | 230 | 6948 | „ |
| 30 | 18.40 | 140 | 1114 | 240 | 8219 | „ |
| 40 | 30.85 | 150 | 1425 | 250 | 9612 | „ |
| 50 | 49.35 | 160 | 1807 | 260 | 11185 | „ |
| 60 | 77.55 | 170 | 2255 | 270 | 12980 | „ |
| 70 | 117.9 | 180 | 2776 | 280 | 15015 | „ |
| 80 | 174.48 | 190 | 3382 | 290 | 17126 | „ |
| 90 | 253.5 | 200 | 4099 | 296.2 | 18730 | „ |
| 100 | 353.6 | | | | | „ |
| 52.927 | 57.53 | 80.134 | 175.82 | 118.924 | 627.77 | Willingham, Taylor, Pignocco and Rossini (1945) |
| 56.456 | 67.35 | 85.916 | 217.16 | 124.319 | 731.94 | „ |
| 59.616 | 77.36 | 91.230 | 261.73 | 124.899 | 743.92 | „ |
| 62.592 | 87.77 | 97.635 | 324.97 | 125.433 | 755.03 | „ |
| 66.587 | 103.68 | 104.233 | 402.38 | 126.035 | 767.96 | „ |
| 71.163 | 124.57 | 111.277 | 500.61 | 126.570 | 779.32 | „ |
| 75.820 | 149.40 | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 125°4 | Bromiley and Quiggle (1933) | 125°658 | Wojciechowski (1936) |
| 125°5 | Vogel (1946) | 125°665 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 125°59 | Shepard, Henne and Midgley (1931) | 125°75 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |
| 125°59 | Mair (1932) | | |
| 125°6 | Bruylants (unpub.) | | |
| 125°6 | Mündel (1913) | 125°75 | Lecat (passim) |
| 125°6 | Rosenbaum (1941) | 125°80 | B. E. (1928) |
| 125°6 | Felsing and Watson (1942) | 125°8 | Young (1900) |
| 125°60 | Chavanne and Tock (1932) | | |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°47 | B. E. (1928) | 0°48 | Shepard, Henne and Midgley (1931) |
| 0°4738 | Forziati, Glasgow Jr., etc. (1946) | 0°48 | Wibaut, Hoog, etc. (1939) |
| 0°477 | Wojciechowski (1936) | 0°48 | Lecat (passim) |
| 0°48 | Young (1910) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −56°8 | Wibaut, Hoog, etc. (1939) | −56°828 | Mair (1932) |
| −56°8 | B. E. (1928) | −56°84 | Ralston, Hoerr and Crews (1944) |
| −56°807 | Streiff, Murphy, Sedlak, Willingham and Rossini (1946) | −56°90 | Shepard, Henne and Midgley (1931) |
| −56°808 | Forziati, Glasgow Jr., etc. (1946) | −56°90 | Felsing and Watson (1942) |

*Isotherms:* Young (1900—10) and Felsing and Watson (1942)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NO_2$ | 20°00 | B. E. (1928) |
| in $C_6H_5NH_2$ | 71°8 | Chavanne and Simon (1919) (corr. 1919, 72°) |
| | 71°8 | Shepard, Henne and Midgley (1931) |
| | 72°1 | Wibaut, Hoog, etc. (1939) |

## Constants of state

### *Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.71852 | B. E. (1928) | 20 | 0.70279 | Shepard, Henne and Midgley (1931) |
| 15 | 0.70657 | ,, | | | |
| 30 | 0.69440 | ,, | 25 | 0.69882 | ,, |
| 0 | 0.71850 | Bruylants (unp.) | 20 | 0.7028 | Vogel (1946) |
| 15 | 0.70665 | ,, | 40.9 | 0.6861 | ,, |
| 30 | 0.69450 | ,, | 61.1 | 0.6700 | ,, |
| 0 | 0.71848 | Young (1910) | 84.9 | 0.6497 | ,, |
| 10 | 0.7102 | ,, | 20 | 0.70280 | Wibaut, Hoog, etc. (1939) |
| 20 | 0.7022 | ,, | 25 | 0.69878 | ,, |
| 30 | 0.6942 | ,, | 20 | 0.7027 | Quayle, Day and Brown |
| 40 | 0.6860 | ,, | 30 | 0.6945 | ,, (1944) |
| 50 | 0.6778 | ,, | 40 | 0.6862 | ,, |
| 0 | 0.71854 | Young and Fortey (1903) | 50 | 0.6781 | ,, |
| 20 | 0.7026 | Bromiley and Quiggle (1933) | 20 | 0.70252 | Forziati, Glasgow Jr., |
| | | | 25 | 0.69849 | ,, etc. (1946) |
| 20 | 0.7027 | Chavanne and Tock(1932) | | | |

### *Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 579 | B. E. (1928) | 20 | 542 | Geist and Cannon (1946) |
| 30 | 472 | ,, | 25 | 508.3 | Shepard, Henne and Midgley (1931) |

### *Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 10 | 22.73 | Harkins and Cheng (1921) | 20 | 21.80 | Quayle, Day and Brown |
| 20 | 21.77 | ,, | 30 | 20.75 | ,, (1944) |
| 30 | 20.76 | ,, | 40 | 19.84 | ,, |
| 15 | 22.27 | Hennaut-Roland and Lek (1931) (corr. Lek, | 50 | 18.82 | ,, |
| | | | 22.9 | 21.32 | Vogel (1946) |
| 20 | 21.75 | ,, 1930) | 23.5 | 21.26 | ,, |
| 30 | 20.79 | ,, | 40.7 | 19.66 | ,, |
| 20 | 21.7 | Smith (1944) | 60.3 | 17.92 | ,, |
| 20 | 21.71 | Wibaut, Hoog, etc. (1939) | 86.0 | 15.59 | ,, |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 1.39736 | 1.39774 | 1.39974 | 1.39991 | 1.40377 | 1.40480 | 1.40775 | — | B. E. (unp.) |
| $\frac{n}{t}$ | 0.00044 | 45 | — | 45 | 45 | 46 | 46 | — | „ |
| 5 | 1.39753 | 1.39777 | 1.39973 | 1.39992 | 1.40377 | 1.40466 | 1.40758 | 1.40872 | Bruylants (unp.) |
| 0 | 1.39091 | 1.39137 | 1.39311 | 1.39320 | 1.39670 | 1.39809 | 1.40087 | 1.40202 | „ |
| $\frac{n}{t}$ | 0.00044 | 43 | 44 | 45 | 47 | 44 | 45 | 45 | „ |
| 0 | — | 1.39557 | 1.39760 | — | — | 1.40255 | — | — | Shepard, Henne and Midgley |
| 5 | — | 1.39328 | 1.39534 | — | — | 1.40030 | — | — | „ |
| 5.3 | — | 1.38334 | 1.38561 | — | — | 1.39037 | — | — | „ (1931) |
| $\frac{n}{t}$ | — | 0.00049 | 48 | — | — | 49 | — | — | „ |
| 0 | — | 1.39562 | 1.39770 | — | — | 1.40252 | — | 1.40648 | Wibaut, Hoog, etc. |
| 5 | — | 1.39321 | 1.39530 | — | — | 1.40004 | — | 1.40411 | „ (1939) |
| $\frac{n}{t}$ | — | 0.00048 | 48 | — | — | 50 | — | 47 | „ |
| 0 | — | — | 1.39743 | — | — | — | — | — | Forziati, Glasgow Jr., etc. (1946) |
| 5 | — | — | 1.39505 | — | — | — | — | — | |
| $\frac{n}{t}$ | — | — | 0.00048 | — | — | — | — | — | „ |
| 0 | — | 1.39544 | 1.39743 | — | — | 1.40227 | — | 1.40576 | Vogel (1946) |
| 0 | — | 1.39559 | 1.39755 | — | — | 1.40238 | — | 1.40652 | Dornte and Smyth (1930) |
| 0 | — | — | 1.3975 | — | — | — | — | — | Rosenbaum (1941) |
| 0 | — | — | 1.39758 | — | — | — | — | — | Felsing and Watson (1942) |
| 5 | — | — | 1.39509 | — | — | — | — | — | Mair (1932) |

*Magnetic rotatory power:* Lowry (1913—14)

**Heat constants**

*Specific heat:* Huffman, Parks and Barmore (1931)
(corr. Huffman, Parks and Thomas (1930))

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −180.76 | 0.198 | −132.96 | 0.263 | L. −46.16 | 0.483 |
| −175.86 | 0.207 | −102.86 | 0.300 | + 1.84 | 0.508 |
| −162.36 | 0.226 | − 93.96 | 0.312 | 13.44 | 0.517 |
| | | | | 25.14 | 0.526 |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25 | 86.800 cal 15° g | Osborne and Ginnings (1947) |
| *Heat of melting* | | 43.21 „ | Huffman, Parks and Barmore |
| *Heat of combustion* | 19° ($c_p$) | 11456.9 „ | Banse and Parks (1933) (1931) |
| | 25° ($c_p$) | 11441.0 „ | Jessup (1937) (M. W. 114.2178) |
| | 30° ($c_p$) | 11437.2 „ | „ |

## 3-METHYLHEPTANE $CH_3-CH_2-CH(CH_3)-(CH_2)_3-CH_3$

### Constants

*Boiling point*

| | | |
|---|---|---|
| 119°0 | | Van Risseghem (1930) |
| 119°05 | $\frac{dt}{dp}$ *(10 mm)*: 0°53 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) |

*Critical solution point* in $C_6H_5NH_2$: 72°2 Wibaut, Hoog, etc. (1939)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.7219 | Van Risseghem (1930) | 20 | 0.7055 | Quayle, Day and Brown |
| 15 | 0.7095 | „ | 30 | 0.6974 | „ (1944) |
| 20 | 0.70584 | Wibaut, Hoog, etc. (1939) | 40 | 0.6892 | „ |
| 25 | 0.70178 | „ | 50 | 0.6811 | „ |
| 20 | 0.7057 | Botcharov and Obolenzev (1946) | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 20 | 21.31 | Quayle, Day and Brown | 20 | 21.2 | Smith (1944) |
| 30 | 20.34 | „ (1944) | | | |
| 40 | 19.34 | „ | | | |
| 50 | 18.43 | „ | | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.39656 | 1.39856 | 1.40344 | 1.40744 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.39413 | 1.39621 | 1.40099 | 1.40493 | „ |
| $\frac{dn}{dt}$ | 0.00049 | 47 | 49 | 50 | „ |
| 15.0 | 1.3990 | 1.4011 | 1.4059 | 1.4100 | Van Risseghem (1930) |
| 20 | — | 1.3986 | — | — | Botcharov and Obolenzev (1946) |

*Heat of vaporisation* 25° 83.346 cal 15° g Osborne and Ginnings (1947)

4-METHYLHEPTANE $CH_3-(CH_2)_2-CH(CH_3)-(CH_2)_2-CH_3$

*Freezing point:* STREIFF, MURPHY, SEDLAK, WILLINGHAM and ROSSINI (1946)
*Density* and *surface tension:* QUAYLE, DAY and BROWN (1944)
*Heat of vaporisation:* OSBORNE and GINNINGS (1947)

2-METHYLHEPTANE $(CH_3)_2-CH-(CH_2)_4-CH_3$ and

3-ETHYLHEXANE $CH_3-CH_2-CH(C_2H_5)-(CH_2)_2-CH_3$

*Density* and *surface tension:* QUAYLE, DAY and BROWN (1944)
*Heat of vaporisation:* OSBORNE and GINNINGS (1947)

2,3 and 2,4-DIMETHYLHEXANES
$CH_3-CH(CH_3)-CH(CH_3)-(CH_2)_2-CH_3$ and $CH_3-CH(CH_3)-CH_2-CH(CH_3)-CH_2-CH_3$

*Boiling* and *critical solution points, surface tension* and *refractive index:* WIBAUT, HOOG, LANGEDYK, OVERHOFF and SMITTENBERG (1939); *heat of vaporisation:* OSBORNE and GINNINGS (1947)

3,3-DIMETHYLHEXANE $CH_3-CH_2-C(CH_3)_2-(CH_2)_2-CH_3$

*Boiling* and *freezing points, density* and *refractive index:* FORZIATI, GLASGOW Jr., WILLINGHAM and ROSSINI (1946); *heat of vaporisation:* OSBORNE and GINNINGS (1947)

3,4-DIMETHYLHEXANE $CH_3-CH_2-CH(CH_3)-CH(CH_3)-CH_2-CH_3$

*Boiling point, density, surface tension* and *refractive index*: VOGEL (1946); *heat of vaporisation:* OSBORNE and GINNINGS (1947)

## BI-*iso*-BUTYL or 2,5-DIMETHYLHEXANE $(CH_3)_2CH-CH_2-CH_2-CH(CH_3)_2$

*Method of preparation*

1° action of sodium upon *iso*-butyl bromide: YOUNG (1910) and YOUNG and FORTEY (1900)

N.B. At the boiling point, *iso*-butyl bromide is partially converted into *tertiary* butyl bromide, this may contaminate the di-*iso*-butyl by traces of hexamethylethane; moreover complete elimination of brominated derivatives is extremely difficult.

2° electrolysis of a solution of potassium *iso*-valerate with a platinum anode.

**Constants:** B.E. (1932). — **Polyphasic equilibria**

*Critical constants*

| t° cr | p cr mm | d cr | |
|---|---|---|---|
| 276.8 | 18660 | 0.2366 | YOUNG (1910) |

*Densities of the liquid and the saturated vapour:* YOUNG (1910)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.71021 | — | 150 | 0.5732 | 0.01070 |
| 10 | 0.7019 | 0.0001 | 160 | 0.5620 | 0.01321 |
| 20 | 0.6934 | 0.0002 | 170 | 0.5503 | 0.01613 |
| 30 | 0.6848 | 0.0002 | 180 | 0.5383 | 0.01959 |
| 40 | 0.6764 | 0.0004 | 190 | 0.5255 | 0.02375 |
| 50 | 0.6677 | 0.0005 | 200 | 0.5117 | 0.02874 |
| 60 | 0.6592 | 0.0008 | 210 | 0.4970 | 0.03484 |
| 70 | 0.6504 | 0.0012 | 220 | 0.4810 | 0.04202 |
| 80 | 0.6417 | 0.0016 | 230 | 0.4633 | 0.05094 |
| 90 | 0.6328 | 0.002339 | 240 | 0.4434 | 0.06223 |
| 100 | 0.6236 | 0.003017 | 250 | 0.4199 | 0.07680 |
| 110 | 0.6143 | 0.003990 | 260 | 0.3912 | 0.09699 |
| 120 | 0.6046 | 0.005219 | 270 | 0.3482 | 0.1321 |
| 130 | 0.5945 | 0.006720 | 274 | 0.3187 | 0.1572 |
| 140 | 0.5841 | 0.008540 | 276.8 | 0.2366 | 0.2366 |

*Rectilinear diameter:* $0.3550 - 0.0004115\ t^{\circ} - 0.0000000592\ t^{\circ 2}$ YOUNG (1900—10)

*Saturated vapour pressure:* YOUNG (1900)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 10 | 13.0 | 80 | 305.5 | 150 | 2116 | 220 | 7937 |
| 20 | 23.05 | 90 | 426.6 | 160 | 2645 | 230 | 9312 |
| 30 | 38.4 | 100 | 578.8 | 170 | 3243 | 240 | 10905 |
| 40 | 61.8 | 110 | 777.1 | 180 | 3938 | 250 | 12668 |
| 50 | 95.95 | 120 | 1020 | 190 | 4740 | 260 | 14651 |
| 60 | 145.2 | 130 | 1319 | 200 | 5670 | 270 | 16905 |
| 70 | 213.3 | 140 | 1685 | 210 | 6733 | 276.8 | 18660 |

| | | | | |
|---|---|---|---|---|
| *Boiling point* | 109°2 | $\frac{dt}{dp}$ *(10 mm)* | 0°47 | YOUNG (1910) |
| | 109°40 | „ | 0°45 | B. E. (1932) |
| | 109°4 | „ | 0°46 | LECAT (passim) |

| | | | |
|---|---|---|---|
| *Critical solution point* | in $C_6H_7NO_2$ | 28°2 | B. E. (1932) |
| | in $C_6H_5NH_2$ | 78°3 | „ |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.71020 | B. E. (1932) | 0° | 0.71021 | Young (1910) |
| 15 | 0.69788 | „ | 12°1 | 0.7001 | Schiff (1883) |
| 30 | 0.68551 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 512 | B. E. (1932) |
| 30 | 432 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 20.21 | B. E. (1932) |
| 20 | 19.66 | „ |
| 30 | 18.87 | „ |
| 20 | 19.8 | Smith (1944) |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.39223 | 1.39265 | 1.39481 | 1.39876 | 1.39983 | 1.40282 |
| $\frac{dn}{dt}$ | 0.00043 | 44 | 45 | 45 | 45 | 47 |

## Heat constants

*Heat of vaporisation:* 25° 79.217 cal 15°/g Osborne and Ginnings (1947)

## 2,2,3-TRIMETHYLPENTANE $(CH_3)_3C-CH(CH_3)-CH_2-CH_3$

The values of Laughlin and Whitmore (1933) disagree with these of Maman (1938) and of Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939)

## Constants

| | | | | |
|---|---|---|---|---|
| *Boiling point* | 109°843 | $\frac{dt}{dp}$ *(10 mm)* | 0°480 | Brooks, Howard and Crafton (1940) |
| | 109°847 | „ | 0°487 | Howard, Mears, Fookson, Pomerantz and Brooks (1947) |

*Freezing point:* —112°32 Brooks, Howard and Crafton (1940)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 0.71617 | Brooks, Howard and Crafton (1940) | 20 | 0.71608 | Howard, Mears, etc. |
| 25 | 0.71218 | „ | 25 | 0.71201 | „ (1947) |

*Refractive index*

| t° | $n_D$ | | t° | $n_D$ | |
|---|---|---|---|---|---|
| 20° | 1.40285 | Brooks, Howard and Crafton (1940) | 20° | 1.40280 | Howard, Mears, etc. |
| 25° | 1.40038 | „ | 25° | 1.40052 | „ (1947) |
| $\frac{dn}{dt}$ | 0.000494 | „ | $\frac{dn}{dt}$ | 0.00049 | „ |

## 2,2,4-TRIMETHYLPENTANE $(CH_3)_3C-CH_2-CH(CH_3)_2$

*Method of preparation:* by dehydration of *tertiary* butylalcohol with sulphuric acid followed by catalytic hydrogenation of the octene (Edgar, 1927). This sample was used by the other workers whose observations corrected Edgar's values.

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 271.15 | 25.50 | 0.237 | Beattie and Edwards (1948) |

*Saturated vapour pressure*

| t° | p mm | |
|---|---|---|
| −30.5 | 1.08 | Linder (1931) |
| −19.0 | 2.58 | „ |

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 38.853 | 92.52 | 74.428 | 355.22 | 111.961 | 1074.58 | Smith (1940) |
| 40.646 | 118.06 | 80.548 | 433.56 | 118.406 | 1268.03 | „ |
| 50.494 | 149.40 | 86.722 | 525.86 | 124.906 | 1489.14 | „ |
| 56.396 | 187.57 | 92.950 | 633.99 | 131.460 | 1740.77 | „ |
| 62.353 | 233.72 | 99.232 | 760.00 | | | „ |
| 68.363 | 289.13 | 105.569 | 906.06 | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 24.274 | 47.66 | 65.524 | 261.73 | Willingham, Taylor, Pignocco and Rossini |
| 28.201 | 57.42 | 71.781 | 324.97 | ,, (1945) |
| 31.620 | 67.23 | 78.240 | 402.47 | ,, |
| 34.722 | 77.28 | 85.141 | 500.76 | ,, |
| 37.609 | 87.72 | 92.634 | 627.98 | ,, |
| 41.519 | 103.67 | 97.926 | 732.14 | ,, |
| 45.977 | 124.65 | 98.495 | 744.13 | ,, |
| 50.505 | 149.39 | 99.022 | 755.32 | ,, |
| 54.711 | 175.91 | 99.610 | 768.10 | ,, |
| 60.346 | 217.22 | 100.138 | 779.50 | ,, |
| 150 | 2597.68 | 225 | 10040.36 | Beattie and Edwards (1948) |
| 175 | 4294.00 | 250 | 14459.76 | ,, |
| 200 | 6740.44 | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 99°10 | Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939) | 99°234 | Smith and Matheson (1938) |
| | | 99°234 | Brooks (1938) |
| | | 99°238 | Forziati, Glascow Jr., Willingham and Rossini (1946) |
| 99°2 | Bromiley and Quiggle (1933) | | |
| 99°2 | Harrison and Berg (1940) | 99°24 | Gelus, Marple Jr. and Miller (1949) |
| 99°2 | Marschner and Cropper (1946) | | |
| 99°232 | Smith (1940) | 99°3 | Edgar (1927) |
| 99°233 | Brooks, Howard and Crafton (1940) | 99°3 | Laughlin and Whitmore (1933) |
| | | 99°3 | Lecat |

$\frac{dt}{dp}$ *(10 mm)*

| | |
|---|---|
| 0°4651 | Brooks (1938); Smith and Matheson (1938) and Forziati, Glasgow Jr. Willingham and Rossini (1946) |

*Freezing point*

| | | | |
|---|---|---|---|
| −107°31 | Brooks (1938) | −107°37 | Brooks, Howard and Crafton (1940) |
| −107°31 | Smith and Matheson (1938) | | |
| −107°365 | Glasgow Jr., Murphy, Willingham and Rossini (1946) and Streiff, Zimmerman, Soule, Butt, Sedlak, Willingham and Rossini (1948) | −107°4 | Hicks-Bruun and Bruun (1932) |
| | | −107°4 | Marschner and Cropper (1946) |
| | | −107°5 | Timmermans (passim) |
| | | −107°5 | Bromiley and Quiggle (1933) |

*Critical solution point* in $C_6H_5NH_2$: 80°4 Wibaut, etc. (1939)

## Constants of state

### *Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.7078 | Smyth and Stoops (1928) | 0 | 0.708120 | Kretschmer, Nowakowska and Wiebe (1948) |
| 10 | 0.6998 | „ | | | |
| 20 | 0.6918 | „ | 25 | 0.687773 | „ |
| 30 | 0.6837 | „ | 50 | 0.666855 | „ |
| 20 | 0.6918 | Laughlin and Whitmore (1933) | 20 | 0.69189 | Brooks, Howard and Crafton (1940) |
| 20 | 0.69182 | Brooks (1938) | 25 | 0.68778 | „ |
| 20 | 0.6919 | Bromiley and Quiggle (1933) | 20 | 0.69192 | Forziati, Glasgow Jr., etc. (1946) |
| 20 | 0.6918 | Grosse and Wackher (1939) | 25 | 0.68777 | „ |

### *Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 18.5 | 543 | Edgar (1927) |
| 20 | 503 | Smyth and Stoops (1928) |

### *Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 18.85 | Wibaut, Hoog, etc. (1939) |
| 20 | 18.9 | Smith (1944) |

### *Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.38962 | 1.39163 | 1.39649 | 1.40074 | Smyth and Stoops (1928) |
| 20 | 1.38944 | 1.39151 | 1.39640 | 1.40042 | Wibaut, Hoog, etc. (1939) |
| 25 | 1.38699 | 1.38906 | 1.39387 | 1.39792 | „ |
| $\frac{dn}{dt}$ | 0.00049 | 49 | 50 | 50 | „ |
| 20 | — | 1.39155 | — | — | Brooks, Howard and Crafton (1940) |
| 25 | — | 1.38915 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00048 | — | — | „ |
| 20 | — | 1.39145 | — | — | Forziati, Glasgow Jr., etc. (1946) |
| 25 | — | 1.38901 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00049 | — | — | „ |
| 20 | — | 1.3913 | — | — | Harrison and Berg (1946) |
| 20 | — | 1.39144 | — | — | Gelus, Marple Jr. and Miller (1949) |
| 20 | — | 1.39146 | — | — | Brooks (1938) |
| 20 | — | 1.3915 | — | — | Woodburn, Smith and Tetewsky (1944) |
| 20 | — | 1.3915 | — | — | Marschner and Cropper (1946) |
| 20 | — | 1.3916 | — | — | Laughlin and Whitmore (1933) |
| 20 | — | 1.3916 | — | — | Bromiley and Quiggle (1933) |

**Heat constants**

*Specific heat:* PARKS, HUFFMAN and THOMAS (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −185.26 | 0.181 | L. −103.56 | 0.388 | −17.96 | 0.452 |
| −181.26 | 0.190 | − 99.76 | 0.390 | + 1.84 | 0.471 |
| −174.96 | 0.201 | − 95.36 | 0.393 | 5.24 | 0.475 |
| −167.66 | 0.217 | − 84.86 | 0.399 | 9.94 | 0.477 |
| −159.96 | 0.232 | − 74.76 | 0.403 | 14.44 | 0.482 |
| −149.96 | 0.250 | − 59.36 | 0.420 | 18.84 | 0.487 |
| −143.76 | 0.260 | − 54.66 | 0.422 | 22.04 | 0.489 |
| −137.96 | 0.271 | − 42.96 | 0.432 | | |
| −132.26 | 0.285 | | | | |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 73.502 cal 15°/g | OSBORNE and GINNINGS (1947) |
| *Heat of melting* | | 18.92 „ | PARKS, HUFFMAN and THOMAS (1930) |

2,3,3-TRIMETHYLPENTANE (A) $(CH_3)_2CH-C(CH_3)_2-CH_2-CH_3$

2-METHYL-3-ETHYLPENTANE (B) $(CH_3)_2CH-CH(C_2H_5)-CH_2-CH_3$

2,3,4-TRIMETHYLPENTANE (C) $(CH_3)_2CH-CH(CH_3)-CH(CH_3)-CH_3$

**Constants:** (A) and (B) HOWARD, MEARS, POMERANTZ, FOOKSON and BROOKS (1947); (C) BROOKS, HOWARD and CRAFTON (1940)

| | | (A) | (B) | (C) |
|---|---|---|---|---|
| *Boiling point* | | 114°767 | 115°653 | 113°391 |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°491 | 0°477 | 0°479 |
| *Freezing point* | | −101°6 | −114°94 | −109°97; |
| *Density* | 20° | 0.72621 | 0.71931 | 0.71903 |
| | 25° | 0.72229 | 0.71523 | 0.71507 |
| *Refractive index* $n_D$ | 20° | 1.40757 | 1.40403 | 1.40431 |
| | 25° | 1.40521 | 1.40173 | 1.40193 |
| $\frac{dn}{dt}$ | | 0.00047 | 0.00046 | 0.000476 |

## HEXAMETHYLETHANE $(CH_3)_3C-C(CH_3)_3$

## 2,2,3,3-TETRAMETHYLBUTANE

Prepared by the action of sodium on *tertiary* butyl bromide.

### Constants

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| −10.3 | 1.33 | Linder (1931) | −0.3 | 3.55 | Linder (1931) |
| −5.0 | 2.08 | „ | +6.0 | 5.80 | „ |

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 3.30 | 4.9 | 39.98 | 47.5 | 99.78 | 629.1 | Calingaert, Soroos, |
| 4.89 | 5.6 | 44.88 | 61.3 | 100.00 | 633.7 | Hnizda and Shapiro |
| 5.88 | 6.0 | 49.99 | 79.4 | 100.02 | 634.3 | „ (1944) |
| 9.87 | 7.8 | 54.88 | 100.3 | 100.03 | 634.6 | „ |
| 10.87 | 8.4 | 59.97 | 127.1 | 101.05 | 655.5 | „ |
| 14.88 | 10.9 | 64.87 | 158.4 | 102.03 | 674.5 | „ |
| 15.89 | 11.6 | 69.98 | 197.6 | 104.03 | 713.3 | „ |
| 19.90 | 14.9 | 79.96 | 298.8 | 106.07 | 755.3 | „ |
| 20.90 | 15.9 | 90.03 | 441.3 | 108.08 | 797.9 | „ |
| 24.91 | 20.4 | 95.00 | 530.1 | 109.57 | 831.8 | „ |
| 25.91 | 21.7 | 97.99 | 589.9 | | | „ |
| 30.02 | 27.8 | 98.98 | 611.3 | | | „ |
| 34.90 | 36.2 | 99.48 | 622.0 | | | „ |

*Boiling point*

| | | |
|---|---|---|
| 106°30 | $\frac{dt}{dp}$ *(10 mm)*: 0°47 | Calingaert, Soroos, Hnizda and Shapiro (1944) |

*Melting point*

| | |
|---|---|
| 100°63 | Seyer, Bennett and Williams (1949) |
| 100°69 | Calingaert, Soroos, Hnizda and Shapiro (1944) |

*Transition points*

| | |
|---|---|
| −125°06 | Parks, Huffman and Thomas (1930) |
| 74°25 and 96°65 | Seyer, Bennett and Williams (1949) |

*Density*: 100°71 0.6568; 102°81 0.6549 Seyer, Bennett and Williams (1949)

*Specific heat:* PARKS, HUFFMAN and THOMAS (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. I −184.36 | 0.166 | − 94.36 | 0.332 | − 22.66 | 0.427 |
| −180.76 | 0.172 | − 84.76 | 0.345 | − 13.46 | 0.438 |
| −174.86 | 0.183 | − 78.86 | 0.353 | + 2.34 | 0.458 |
| −167.36 | 0.198 | − 68.76 | 0.369 | 7.84 | 0.466 |
| −159.66 | 0.213 | − 63.66 | 0.374 | 18.04 | 0.481 |
| | | − 49.36 | 0.394 | 22.24 | 0.486 |
| C. II −111.86 | 0.308 | − 44.06 | 0.400 | | |
| −100.16 | 0.326 | − 30.66 | 0.417 | | |

| | | | |
|---|---|---|---|
| *Heat of transition* | −125°06 | 4.20 cal 15°/g | PARKS, HUFFMAN and THOMAS (1930) |

## HIGHER PARAFFINS

The higher paraffins, which are liquid or crystalline at ordinary temperature, have generally been prepared by one of the following methods:

1° Extraction from petroleum ether by treatment with chlorosulphonic acid, and fractional distillation (SHEPARD, HENNE and MIDGLEY, 1931).

2° Reduction of the corresponding acid, ketone or iodide (KRAFFT, 1882).

3° For even compounds: WÜRTZ synthesis by the action of sodium on halogenated derivatives containing one half of the number of carbon atoms.

4° For *iso* compounds: application of the GRIGNARD method to aldehydes, formation of isomeric alcohols, dehydration and subsequent hydrogenation (method of EDGAR, CALINGAERT and MARKER).

EYKMAN, in his posthumous works, gave the refractive indices for eight wavelengths of a fair number of isomeric paraffins in $C_8$, $C_9$, $C_{10}$, etc.: his preparations were made with great care, but we do not, however, regard his values as reliable, since in those cases where there is material for comparison (e.g., di*iso*amyl) his results are not altogether exact.

### *n*-NONANE $n$-$C_9H_{20}$

**Constants**

*Boiling point*

| | | | |
|---|---|---|---|
| 150°55 | CHAVANNE and TOCK (1932) | 150°72 | MAIR (1932) |
| 150°55 | VOGEL (1946) | 150°73 | WHITE and ROSE (1931) |
| 150°71 | SHEPARD, HENNE and MIDGLEY (1931) | 150°81 | WOJCIECHOWSKI (1939) |

$\frac{dt}{dp}$ *(10 mm)*

| | |
|---|---|
| 0°497 | Wojciechowski (1939) |

*Freezing point*

| | | | |
|---|---|---|---|
| −53°535 | Streiff, Murphy, Cahill, Flanagan, Sedlak, Willingham and Rossini (1947) | −53°68 | Shepard, Henne and Midgley (1931) |
| −53°65 | White and Rose (1931) | −53°70 | Mair (1932) |

*Transition point:* −56°46 Huffman, Parks and Barmore (1931)

*Critical solution point* in $C_6H_5NH_2$: 74°4 Shepard, Henne and Midgley (1931)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.7330 | Krafft (1882) | 0 | 0.73300 | Bruylants (unp.) |
| 13.5 | 0.7228 | „ | 15 | 0.72159 | „ |
| 15 | 0.7217 | „ | 30 | 0.70988 | „ |
| 20 | 0.7177 | „ | 20 | 0.7175 | Quayle, Day and Brown |
| 0 | 0.7330 | Chavanne and Tock (1932) | 30 | 0.7097 | „ (1944) |
| 20 | 0.7176 | „ | 40 | 0.7020 | „ |
| 20 | 0.71780 | Shepard, Henne and Midgley (1931) | 20 | 0.7174 | Vogel (1946) |
| | | | 41.5 | 0.7015 | „ |
| 25 | 0.71328 | „ | 61.8 | 0.6858 | „ |
| 20 | 0.71793 | White and Rose (1931) | 85.6 | 0.6672 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 0 | 969 | 40 | 548 | Bingham (1910) |
| 10 | 824 | 60 | 438 | „ |
| 20 | 711 | 80 | 359 | „ |
| 30 | 619 | 100 | 209 | „ |
| 25 | 662.1 | | | Shepard, Henne and Midgley (1931) |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 17.4 | 23.02 | Vogel (1946) | 20 | 22.91 | Quayle, Day and Brown (1944) |
| 20.6 | 22.80 | „ | 30 | 21.92 | „ |
| 26.3 | 22.28 | „ | 40 | 20.96 | „ |
| 41.4 | 20.79 | „ | | | |
| 61.2 | 18.97 | „ | | | |
| 87.7 | 16.67 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40525 | 1.40553 | 1.40760 | 1.40773 | 1.41161 | 1.41258 | 1.41557 | 1.41654 | Bruylants (unp.) |
| 30 | 1.39883 | 1.39923 | 1.40115 | 1.40125 | 1.40474 | 1.40611 | 1.40901 | 1.41024 | „ |
| $\frac{dn}{dt}$ | 0.00043 | 42 | 43 | 43 | 45 | 43 | 44 | 42 | „ |
| 20 | — | 1.40356 | 1.40563 | — | — | 1.41077 | — | — | Shepard, Henne and Midgley |
| 25 | — | 1.40125 | 1.40340 | — | — | 1.40846 | — | — | „ (1931) |
| 45.3 | — | 1.39181 | 1.39389 | — | — | 1.39883 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00047 | 47 | — | — | 48 | — | — | „ |
| 20 | — | 1.40351 | 1.4055 | — | — | 1.41043 | — | 1.41458 | Dornte and Smyth (1930) |
| 20 | — | 1.40339 | 1.40543 | — | — | 1.41041 | — | 1.41420 | Vogel (1946) |
| 25 | — | — | 1.40335 | — | — | — | — | — | White and Rose (1931) |
| 25 | — | — | 1.4035 | — | — | — | — | — | Krafft (1882) |

*Specific heat:* Huffman, Parks and Barmore (1931)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −180.36 | 0.195 | −123.06 | 0.271 | L. −44.86 | 0.489 | + 2.14 | 0.508 |
| −175.56 | 0.203 | −110.06 | 0.288 | −39.46 | 0.489 | 9.64 | 0.514 |
| −159.36 | 0.227 | − 93.86 | 0.309 | −28.16 | 0.491 | 15.74 | 0.518 |
| −136.36 | 0.256 | − 85.46 | 0.322 | −13.76 | 0.498 | 23.74 | 0.523 |

| | | |
|---|---|---|
| *Heat of combustion* | 30° ($c_v$) 11379.8 cal 15°/g | Jessup (1937) (M. W. 128.243) |
| | 30° ($c_p$) 11403.6 „ | „ |
| | 25° ($c_p$) 11407.3 „ | „ |

## *Iso*-NONANES

2-METHYLOCTANE $(CH_3)_2CH-(CH_2)_5-CH_3$
3-METHYLOCTANE $CH_3-CH_2-CH(CH_3)-(CH_2)_4-CH_3$
4-METHYLOCTANE $CH_3-(CH_2)_2-CH(CH_3)-(CH_2)_3-CH_3$
2,5-DIMETHYLHEPTANE $(CH_3)_2CH-(CH_2)_2-CH(CH_3)-CH_2-CH_3$

*Boiling point:* Wojciechowski (1939)

## 2.6-DIMETHYLHEPTANE $CH_3-CH(CH_3)-(CH_2)_3-CH(CH_3)-CH_3$

Prepared by hydrogenation of the 2,6-dimethylheptanol-1 obtained by the action of *iso*-butylmagnesium bromide on ethyl formate. White and Rose (1936) and White, Rose, Calingaert and Soroos (1939).

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 135°21 | $\frac{dt}{dp}$ *(10 mm)* | 0°49 | Wojciechowski (1939) |
| 135°21 | „ | 0°490 | White and Rose (1936) and White, Rose, Calingaert and Soroos (1939) |

*Melting point*

| | |
|---|---|
| −102°95 | White, Rose, Calingaert and Soroos (1939) |
| −103°25 | White and Rose (1936) |

*Critical solution point* in $C_6H_5NH_2$: 80·0 White, Rose, Calingaert and Soroos (1939)

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.70891 | White, Rose, Calingaert and Soroos (1939) |

*Refractive index*

| t° | D | |
|---|---|---|
| 20 | 1.40073 | White, Rose, Calingaert and Soroos (1939) |
| $\frac{dn}{dt}$ | 0.00049 | „ |

A. TRIMETHYLHEXANES

2,2,4- $= (CH_3)_3C-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_3$

2,2,5- $= (CH_3)_3C-CH_2-CH_2-CH(CH_3)_2$

2,3,5- $= (CH_3)_2CH-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH(CH_3)_2$

B. DIMETHYLETHYLPENTANES

2,2,3- $= (CH_3)_3C-\underset{\displaystyle C_2H_5}{\underset{|}{CH}}-CH_2-CH_3$

2,4,3- $= (CH_3)_2CH-\underset{\displaystyle C_2H_5}{\underset{|}{CH}}-CH(CH_3)_2$

| | A | | | B | |
|---|---|---|---|---|---|
| | 2,2,4- | 2,2,5- | 2,3,5- | 2,2,3- | 2,4,3- |
| **Constants:** Howard, Mears, Fookson, Pomerantz and Brooks (1947) | | | | | |
| *Boiling point* | 126°45 | 124°092 | 131°37 | 133°834 | 136°717 |
| $\frac{dt}{dp}$ *(10 mm)* | 0°503 | 0°485 | 0°492 | 0°506 | 0°504 |
| *Melting point* | −123°4 | −105°89 | −127°9 | −99°3 | −122°4 |
| *Density* 20° | 0.71555 | 0.70711 | 0.72191 | 0.73478 | 0.73793 |
| 25° | 0.71178 | 0.70313 | 0.71792 | 0.73100 | 0.73415 |
| *Refractive index* $n_D$ | | | | | |
| 20° | 1.40328 | 1.39956 | 1.40601 | 1.41227 | 1.41371 |
| 25° | 1.40095 | 1.39724 | 1.40365 | 1.41014 | 1.41146 |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 47 | 43 | 43 |
| *Heat of vaporisation* 25° cal 15°/g | — | 74.869 | 77.190 | — | — |
| Osborne and Ginnings (1947) | | | | | |

## TETRAETHYLMETHANE or 3,3-DIETHYLPENTANE $C(C_2H_5)_4$

**Constants**

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 145°68 | Mathot (unp.) | 31°6<br>33°110 | Mathot (unp.)<br>Streiff, Murphy, Cahill, Flanagan, Sedlak, Willingham and Rossini (1947) |

| *Density* | | *Viscosity* | | *Surface tension* | |
|---|---|---|---|---|---|
| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ |
| 0 | 0.76757 | 15 | 863 | 15 | 24.44 |
| 15 | 0.75687 | 30 | 696 | 20 | 23.95 |
| 30 | 0.74610 | | | 30 | 22.76 |

*Dielectric constant:* 20° 1.998 PIETTE (unp.)

## TETRAMETHYLPENTANES

$(CH_3)_3C-C(CH_3)_2-CH_2-CH_3$ (2,2,3,3-) (A)

$(CH_3)_3C-CH(CH_3)-CH(CH_3)_2$ (2,2,3,4-) (B)

$(CH_3)_3C-CH_2-C(CH_3)_3$ (2,2,4,4-) (C)

$(CH_3)_2CH-C(CH_3)_2-CH(CH_3)_2$ (2,3,3,4-) (D)

**Constants:** (I) STREIFF, MURPHY, CAHILL, FLANAGAN, SEDLAK, WILLINGHAM and ROSSINI (1946)

(II) HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947)

(III) HOWARD (1940); (IV) SMITH (1941)

| | | (A) | (B) | (C) | (D) |
|---|---|---|---|---|---|
| *Boiling point* | | 140°264 (II) | 133°010 (II) | 122°281 (III)<br>122°283 (IV) | 141°544 (II) |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°512 „ | 0°501 „ | 0°492 (III) | 0°514 „ |
| *Melting point* | | −9°90 (I)<br>−10°04 (II) | −121°09 (I)<br>−122°2 (II) | −66°600 (III)<br>−66°54 (I) | −102°14 (II)<br>−102°123 (I) |
| *Density* | 20° | 0.75676 (II) | 0.73915 (II) | 0.71957 (III) | 0.75489 (II) |
| | 25° | 0.75300 „ | 0.73537 „ | 0.71556 „ | 0.75112 „ |
| *Refractive index* | | $n_D$ | $n_D$ | $n_D$ | $n_D$ |
| | 20° | 1.42365 (II) | 1.41462 (II) | 1.40677 (III) | 1.42222 (II) |
| | 25° | 1.42146 „ | 1.41242 „ | 1.40451 „ | 1.42005 „ |
| | $\frac{dn}{dt}$ | 0.00044 „ | 0.00044 „ | — | 0.00043 „ |

*Saturated vapour pressure* of (C) $(CH_3)_3C—CH_2—C(CH_3)_3$

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 58.356 | 99.52 | 102.438 | 433.56 (IV) | Smith (1941) |
| 64.448 | 118.06 | 108.994 | 525.86 „ | „ |
| 70.611 | 149.40 | 115.610 | 633.99 „ | „ |
| 76.844 | 187.57 | 129.014 | 906.06 „ | „ |
| 83.145 | 233.72 | 135.799 | 1074.58 „ | „ |
| 89.511 | 289.13 | 142.638 | 1268.03 „ | „ |
| 95.943 | 355.22 | 149.528 | 1489.4 „ | „ |

## *n*-DECANE $n$-$C_{10}H_{22}$

A number of physical constants that were given for *n*-decane do, in fact, correspond to di-*iso*-amyl.

*Boiling point*

| | | | |
|---|---|---|---|
| 173°95 | Chavanne and Tock (1932) | 174°02 | Mair (1932) |
| 174°0 | Bruun and Hicks-Bruun (1932) | 174°06 | Shepard, Henne and Midgley (1931) |

*Freezing point*

| | | | |
|---|---|---|---|
| −29°673 | Streiff, Murphy, Zimmerman, Soule, Sedlak, Willingham and Rossini (1947) | −29°76 | Shepard, Henne and Midgley (1931) |
| | | −30° | Huffman, Parks and Barmore (1931) |
| −29°68 | Bruun and Hicks-Bruun (1932) | | |
| −29°68 | Mair (1932) | | |

*Isotherms:* Reamer, Olds, Sage and Lacey (1942)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 77°5 | Shepard, Henne and Midgley (1931) |
| | 77°6 | Bruun and Hicks-Bruun (1932) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.74487 | Bruylants (unp.) | 0 | 0.7448 | Chavanne and Tock (1932) |
| 15 | 0.73373 | „ | 20 | 0.7298 | „ |
| 20 | 0.72996 | „ | 20 | 0.73014 | Shepard, Henne and Midgley (1931) |
| 30 | 0.72238 | „ | 25 | 0.72643 | „ |
| | | | 20 | 0.72994 | Bruun and Hicks-Bruun (1932) |

*Viscosity:* 25° $852.7 \cdot 10^{-5}$ Shepard, Henne and Midgley (1931)

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41155 | 1.41185 | 1.41400 | 1.41414 | 1.41807 | 1.41908 | 1.42206 | 1.42315 | Bruylants (unp.) |
| 30 | 1.40529 | 1.40565 | 1.40768 | 1.40778 | 1.41131 | 1.41217 | 1.41568 | 1.41685 | „ |
| $\frac{dn}{dt}$ | 0.00042 | 41 | 42 | 43 | 45 | 42 | 43 | 42 | „ |
| 20 | — | 1.40994 | 1.41203 | — | — | 1.41728 | — | — | Shepard, Henne |
| 25 | — | 1.40771 | 1.40986 | — | — | 1.41492 | — | — | and Midgley |
| 45.3 | — | 1.39831 | 1.40047 | — | — | 1.40549 | — | — | „ (1931) |
| $\frac{dn}{dt}$ | — | 0.00043 | 43 | — | — | 47 | — | — | „ |
| 20 | — | 1.40999 | 1.41206 | — | — | 1.41715 | — | 1.42080 | Vogel (1946) |
| 25 | — | — | 1.40961 | — | — | — | — | — | Mair (1932) |
| 25 | — | — | 1.40960 | — | — | — | — | — | Bruun and Hicks-Bruun (1932) |

*Specific heat:* Huffman, Parks and Barmore (1931)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −181.86 | 0.188 | −143.06 | 0.239 | −92.96 | 0.297 | L. −21.96 | 0.495 |
| −176.36 | 0.196 | −133.66 | 0.250 | −82.56 | 0.310 | −11.06 | 0.500 |
| −170.96 | 0.204 | −123.16 | 0.262 | −72.96 | 0.323 | + 2.04 | 0.509 |
| −166.16 | 0.210 | −113.56 | 0.273 | −62.66 | 0.338 | 8.14 | 0.512 |
| −159.26 | 0.219 | −103.06 | 0.285 | −52.56 | | 15.64 | 0.517 |
| −152.46 | 0.228 | | | | | 24.54 | 0.523 |

| | | |
|---|---|---|
| *Heat of melting* | 48.34 cal 15° g | Huffman, Parks and Barmore (1931) |
| *Heat of combustion* | 30° ($c_v$) 11355.2 „ | Jessup (1937) (M. W. 142.2682) |
| | 30° ($c_p$) 11378.6 „ | „ |
| | 25° ($c_p$) 11382.3 „ | „ |
| | 25° ($c_p$) 11387.2 „ | Prosen and Rossini (1944) (M. W. 142.276) |

## BI-*iso*-AMYL or 2,7-DIMETYLOCTANE $(CH_3)_2CH-(CH_2)_4-CH(CH_3)_2$

Most of the values given for di-*iso*-amyl are unreliable owing to the presence of a small amount of the *iso*-amyl iodide or bromide used in the WÜRTZ synthesis. In order to eliminate these impurities, it is necessary to treat the hydrocarbon with concentrated sulphuric acid and this operation must be followed by fractional distillation.

**Constants**: TIMMERMANS and HENNAUT-ROLAND (1929)

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 160°00<br>160°1 | $\frac{dt}{dp}$ *(10 mm)* 0°50<br>LECAT (passim) | —49°2 | TIMMERMANS and HENNAUT-ROLAND (1929) |

| *Density* | | *Viscosity* | |
|---|---|---|---|
| t° | d | t° | $\eta \cdot 10^5$ |
| 0 | 0.73785 | 15 | 889 |
| 15 | 0.72640 | 30 | 703 |
| 30 | 0.71494 | | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 22.78 | TIMMERMANS and HENNAUT-ROLAND (1929), LEK (1930), HENNAUT-ROLAND and LEK (1931) |
| 20 | 22.22 | |
| 30 | 21.14 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.40787 | 1.40830 | 1.41049 | 1.41050 | 1.41447 | 1.41564 | 1.41853 |
| $\frac{dn}{dt}$ | 0.00044 | 44 | 45 | 45 | 45 | — | — |

| | | |
|---|---|---|
| 2-METHYLNONANE | $(CH_3)_2\,CH-(CH_2)_6-CH_3$ | (A) |
| 3- ,, | $CH_3-CH_2-CH(CH_3)-(CH_2)_5-CH_3$ | (B) |
| 4- ,, | $CH_3-(CH_2)_2-CH(CH_3)-(CH_2)_4-CH_3$ | (C) |
| 5- ,, | $CH_3-(CH_2)_3-CH(CH_3)-(CH_2)_3-CH_3$ | (D) |

**Constants**: CALINGAERT and SOROOS (1936) I and PARKS, WEST and MOORE (1941) II

| | | (A) | (B) | (C) | (D) | |
|---|---|---|---|---|---|---|
| *Boiling point* | | 166°8 | 167°8 | — | 165°1 | (I) |
| *Freezing point* | | −74°36 | −84°66 | 98°46 | −86°46 | (II) |
| | | −74°69 | −84°86 | — | −86°80 | (I) |
| *Density* | 20° | 0.72805 | 0.73335 | — | 0.73225 | (I) |
| *Refractive index* | $n_D^{20°}$ | 1.4099 | 1.4125 | — | 1.4122 | (I) |
| *Critical solution point* in $C_6H_5NH_2$ | | 80°3 | 78°25 | — | 77°9 | (I) |

*Specific heat*: II

| (A) | | (B) | (C) | | (D) |
|---|---|---|---|---|---|
| t° | $c_p$ | $c_p$ | $c_p$ | $c_p$ | $c_p$ |
| C. −193.16 | 0.1757 | C. 0.1691 | C. I 0.1732 | C. II 0.1810 | C. 0.1748 |
| −183.16 | 0.1909 | 0.1848 | 0.1891 | 0.1991 | 0.1910 |
| −173.16 | 0.2063 | 0.2000 | 0.2052 | 0.2175 | 0.2059 |
| −163.16 | 0.2211 | 0.2146 | 0.2211 | 0.254 | 0.2202 |
| −153.16 | 0.2350 | 0.2285 | 0.2349 | 0.427 | 0.2341 |
| −143.16 | 0.2475 | 0.2425 | 0.2470 | 0.438 | 0.2479 |
| −133.16 | 0.2600 | 0.2563 | 0.2598 | 0.438 | 0.2605 |
| −123.16 | 0.2724 | 0.2688 | 0.2745 | — | 0.2730 |
| −113.16 | 0.2848 | 0.2803 | 0.325 | — | 0.2862 |
| −103.16 | 0.3020 | 0.2979 | | | 0.3075 |
| − 93.16 | 0.343 | 0.340 | L. 0.4440 | | 0.360 |
| − 83.16 | 0.464 | L. 0.4426 | 0.4450 | | L. 0.4448 |
| L. − 73.16 | 0.4680 | 0.4477 | 0.4510 | | 0.4491 |
| − 63.16 | 0.4688 | 0.4530 | 0.4570 | | 0.4544 |
| − 53.16 | 0.4705 | 0.4580 | 0.4630 | | 0.4599 |
| − 43.16 | 0.4738 | 0.4632 | 0.4690 | | 0.4663 |
| − 33.16 | 0.4782 | 0.4694 | 0.4758 | | 0.4739 |
| − 23.16 | 0.4849 | 0.4766 | 0.4844 | | 0.4815 |
| − 13.16 | 0.4922 | 0.4850 | 0.4938 | | 0.4994 |
| − 3.16 | 0.5003 | 0.4939 | 0.5029 | | 0.5090 |
| + 6.84 | 0.5095 | 0.5030 | 0.5126 | | 0.5187 |
| 16.84 | 0.5186 | 0.5119 | 0.5240 | | 0.5282 |
| 26.84 | 0.5263 | 0.5190 | 0.5331 | | |
| *Heat of melting* cal 15°/g | | | | | |
| 29.38 | | 31.41 | 25.51 | | 27.95 |

(A) TETRAMETHYLHEXANES

2,2,3,3- = $(CH_3)_3C-C(CH_3)_2-(CH_2)_2-CH_3$
2,2,4,5- = $(CH_3)_3C-CH_2-CH(CH_3)-CH(CH_3)_2$
2,2,5,5- = $(CH_3)_3C-(CH_2)_2-C(CH_3)_3$

(B) PENTAMETHYLPENTANES

2,2,3,3,4- = $(CH_3)_3C-C(CH_3)_2-CH(CH_3)_2$
2,2,3,4,4- = $(CH_3)_3C-CH(CH_3)-C(CH_3)_3$

(C) DIMETHYL-*iso*-PROPYLPENTANE

2,4,3- = $(CH_3)_2CH-CH[CH(CH_3)_2]-CH(CH_3)_2$

**Constants**: Howard, Mears, Fookson, Pomerantz and Brooks (1947)

| | | (A) | | | (B) | | (C) |
|---|---|---|---|---|---|---|---|
| | | 2,2,3,3- | 2,2,4,5- | 2,2,5,5- | 2,2,3,3,4- | 2,2,3,4,4- | 2,4,3- |
| *Boiling point* | | 160°310 | 147°875 | 137°452 | 166°05 | 159°29 | 157°042 |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°538 | 0°512 | 0°500 | 0°552 | 0°537 | 0°544 |
| *Freezing point* | | −54°03 | – | −12°64 | −36°49 | −38°81 | −81°75 |
| *Density* | 20° | 0.76450 | 0.73542 | 0.71875 | 0.78009 | 0.76702 | 0.75826 |
| | 25° | 0.76080 | 0.73165 | 0.71480 | 0.77675 | 0.76362 | 0.75460 |
| *Refractive index* | | | | | | | |
| | $n_D^{20°}$ | 1.42812 | 1.41321 | 1.40550 | 1.43606 | 1.43069 | 1.42465 |
| | $n_D^{25°}$ | 1.42606 | 1.41093 | 1.40315 | 1.43412 | 1.42868 | 1.42246 |
| | $\frac{dn}{dt}$ | 0.00041 | 46 | 47 | 39 | 40 | 44 |

## *n*-UNDECANE $n$-$C_{11}H_{24}$

**Constants**

*Boiling point:* 195°84 Shepard, Henne and Midgley (1931)

*Melting point*

| | | | |
|---|---|---|---|
| −25°61 | Mair (1932) | −25°9 | Huffman, Parks and Barmore (1931) |
| −25°65 | Shepard, Henne and Midgley (1931) | | |

*Transition point:* −37°0 Huffman, Parks and Barmore (1931)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 80°6 | Shepard, Henne and Midgley (1931) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.75483 | Bruylants (unp.) | 20 | 0.74025 | Shepard, Henne and Midgley |
| 15 | 0.74390 | „ | 25 | 0.73667 | „ (1931) |
| 30 | 0.73282 | „ | | | |

*Viscosity:* 25° $1081 \cdot 10^{-5}$ Shepard, Henne and Midgley (1931)

*Refractive index*

| t° | He r. | Hα | D | He y. | Heg. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41688 | 1.41718 | 1.41922 | 1.41934 | 1.42343 | 1.42443 | 1.42747 | 1.42865 | Bruylants (unp.) |
| 30 | 1.41072 | 1.41106 | 1.41305 | 1.41322 | 1.41675 | 1.41822 | 1.42134 | 1.42235 | „ |
| $\frac{dn}{dt}$ | 0.00041 | 41 | 41 | 41 | 45 | 41 | 41 | 42 | „ |
| 20 | — | 1.41514 | 1.41727 | — | — | 1.42252 | — | — | Shepard, Henne |
| 25 | — | 1.41300 | 1.41516 | — | — | 1.42036 | — | — | and Midgley |
| 45.3 | — | 1.40384 | 1.40611 | — | — | 1.41111 | — | — | „ (193 |
| $\frac{dn}{dt}$ | — | 0.00043 | 42 | — | — | 43 | — | — | „ |
| 25 | — | — | 1.41495 | — | — | — | — | — | Mair (1932) |

## Heat constants

*Specific heat:* Huffman, Parks and Barmore (1931)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −181.16 | 0.188 | −132.96 | 0.250 | L. −14.66 | 0.503 |
| −175.66 | 0.196 | −115.06 | 0.271 | + 1.74 | 0.511 |
| −160.76 | 0.215 | − 83.06 | 0.310 | 10.26 | 0.515 |
| | | | | 17.64 | 0.520 |
| | | | | 24.84 | 0.524 |

| | | |
|---|---|---|
| *Heat of transition* | 9.69 cal 15°/g | Huffman, Parks and Barmore |
| *Heat of melting* | 34.12 „ | „ (1931) |
| *Heat of combustion* | 30° ($c_v$) 11331.0 „ | Jessup (1937) ; M. W. 156.2°C4 |
| | 30° ($c_p$) 11354.7 „ | ... |
| | 25° ($c_p$) 11358.4 „ | ... |

## *n*-DODECANE $n\text{-}C_{12}H_{26}$

### Constants

*Saturated vapour pressure:* WILLINGHAM, TAYLOR, PIGNOCCO and ROSSINI (1945)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 126.381 | 47.74 | 147.151 | 103.63 | 176.039 | 261.74 | 214.709 | 732.02 |
| 131.108 | 57.48 | 152.529 | 124.59 | 183.537 | 325.01 | 215.383 | 743.98 |
| 135.223 | 67.29 | 157.986 | 149.39 | 191.255 | 402.44 | 216.006 | 755.10 |
| 138.962 | 77.30 | 163.030 | 175.84 | 199.488 | 500.67 | 216.712 | 767.95 |
| 142.444 | 87.73 | 169.814 | 217.13 | 208.417 | 627.81 | 217.345 | 779.39 |

*Boiling point*

| | | | |
|---|---|---|---|
| 216°23 | SHEPARD, HENNE and MIDGLEY (1931) | 216°275 | WILLINGHAM, TAYLOR, PIGNOCCO and ROSSINI (1945) |
| 216°26 | MAIR and STREIFF (1940) | | |

*Melting point*

| | | | |
|---|---|---|---|
| −9°6 | HUFFMAN, PARKS and BARMORE (1931) | −9°64 | RALSTON, HOERR and CREWS (1944) |
| −9°60 | MAIR and STREIFF (1940) | −9°73 | SHEPARD, HENNE and MIDGLEY (1931) |
| −9°604 | DEANESLY and CARLETON (1941) | | |
| −9°61 | MAIR (1932) | | |

*Critical solution point* in $C_6H_5NH_2$: 83°7 SHEPARD, HENNE and MIDGLEY (1931)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.76327 | BRUYLANTS (unp.) | 20 | 0.74876 | DEANESLY and CARLETON (1941) |
| 15 | 0.75248 | „ | 25 | 0.74512 | MAIR and STREIFF (1940) |
| 30 | 0.74157 | „ | | | |

*Viscosity:* 25° $1353 \cdot 10^{-5}$ SHEPARD, HENNE and MIDGLEY (1931)

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42136 | 1.42160 | 1.42371 | 1.42381 | 1.42795 | — | 1.43205 | 1.43325 | BRUYLANTS (unp.) |
| 30 | 1.40536 | 1.41567 | 1.41753 | 1.41780 | 1.42154 | — | 1.42613 | 1.42713 | „ |
| $\frac{dn}{dt}$ | 0.00040 | 40 | 41 | 40 | 42 | | 39 | 40 | „ |
| 20 | — | 1.41936 | 1.42152 | — | — | 1.42673 | — | — | DEANESLY and CARLETON (1941) |
| $\frac{dn}{dt}$ | — | — | 0.000404 | — | — | — | — | — | |
| 25 | — | 1.41736 | 1.41951 | — | — | 1.42469 | — | — | MAIR and STREIFF (1940) |

*Specific heat:* Huffman, Parks and Barmore (1931)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −179.86 | 0.184 | −113.86 | 0.264 | L. +1.94 | 0.510 |
| −173.66 | 0.194 | −102.16 | 0.277 | 9.74 | 0.514 |
| −166.86 | 0.202 | − 86.86 | 0.295 | 16.54 | 0.518 |
| −159.46 | 0.212 | − 75.56 | 0.309 | 24.54 | 0.521 |
| −149.06 | 0.225 | − 61.76 | 0.326 | | |
| −136.76 | 0.239 | − 49.16 | 0.344 | | |
| −125.16 | 0.252 | | | | |

| | | |
|---|---|---|
| *Heat of melting* | 51.33 cal 15 g | Huffman, Parks and Barmore (1931) |
| *Heat of combustion* | 19° ($c_p$) 11357.1 ,, | Banse and Parks (1933) (M.W. 170.21) |
| | 25° ($c_p$) 11344.9 ,, | Jessup (1937) (M.W. 170.3186) |
| | 30° ($c_p$) 11341.2 ,, | ,, |
| | 30° ($c_v$) 11318.0 ,, | ,, |
| | 25° ($c_p$) 11347.1 ,, | Prosen and Rossini (1944) (M.W. 170.328) |

## *n*-TRIDECANE $n$-$C_{13}H_{28}$

**Constants:** Bruylants (unp.)

*Boiling point:* 234°0 Lecat (passim)

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.77049 | Bruylants (unp.) |
| 15 | 0.75986 | ,, |
| 30 | 0.74915 | ,, |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42516 | 1.42544 | 1.42756 | 1.42766 | 1.43195 | 1.43293 | 1.43599 | 1.43724 | Bruylants (unp.) |
| 30 | 1.41920 | 1.41952 | 1.42160 | 1.42173 | 1.42550 | 1.42687 | 1.43032 | 1.43169 | ,, |
| $\frac{dn}{dt}$ | 0.00039 | 39 | 39 | 39 | 42 | 40 | 37 | 41 | ,, |

## *n*-TETRADECANE $n$-$C_{14}H_{30}$

### Constants

*Freezing point*

| | | | |
|---|---|---|---|
| 5°5 | PARKS and LIGHT (1934) | 5°6 | VAN HOOK and SILVER (1942) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.76632 | BRUYLANTS (unp.) | 20 | 0.7624 | VOGEL (1946) |
| 30 | 0.75559 | „ | 40.6 | 0.7494 | „ |
| | | | 61.5 | 0.7348 | „ |
| | | | 86.3 | 0.7175 | „ |

*Surface tension*

| t° | $\gamma$ | t° | $\gamma$ | |
|---|---|---|---|---|
| 21.5 | 26.53 | 60.2 | 23.15 | VOGEL (1946) |
| 25.2 | 26.16 | 87.8 | 20.84 | „ |
| 40.9 | 24.90 | | | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42845 | 1.42882 | 1.43092 | 1.43097 | 1.43523 | 1.43628 | 1.43941 | 1.44064 | BRUYLANTS (unp.) |
| 30 | 1.42260 | 1.42297 | 1.42501 | 1.42515 | 1.42895 | 1.43033 | 1.43364 | 1.43468 | „ |
| $\frac{dn}{dt}$ | 0.00039 | 39 | 39 | 39 | 42 | 39 | 38 | 39 | „ |
| 20 | — | 1.42688 | 1.42907 | — | — | 1.43433 | — | 1.43818 | VOGEL (1946) |
| 20 | — | — | 1.4290 | — | — | — | — | — | VAN HOOK and SILVER (1942) |
| $\frac{dn}{dt}$ | — | — | 0.000410 | — | — | — | — | — | |

*Specific heat:* PARKS and LIGHT (1934)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −179.86 | 0.180 | −122.06 | 0.250 | −50.36 | 0.337 |
| −174.36 | 0.188 | −109.16 | 0.263 | −41.76 | 0.348 |
| −167.86 | 0.196 | −98.36 | 0.277 | −37.36 | 0.357 |
| −163.76 | 0.201 | −88.76 | 0.292 | L. + 7.44 | 0.517 |
| −152.06 | 0.216 | −72.26 | 0.311 | 11.24 | 0.520 |
| −139.96 | 0.230 | −68.66 | 0.312 | 13.14 | 0.521 |
| −133.76 | 0.238 | −59.56 | 0.323 | 17.44 | 0.523 |

## *n*-PENTADECANE $n\text{-}C_{15}H_{32}$

**Constants:** BRUYLANTS (unp.)

*Freezing point:* 10° KRAFFT (1882)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.77197 | BRUYLANTS (unp.) | 20 | 0.7687 | VOGEL (1946) |
| 30 | 0.76146 | „ | 41.0 | 0.7549 | „ |
| | | | 61.4 | 0.7412 | „ |
| | | | 86.7 | 0.7236 | „ |

*Surface tension*

| t° | $\gamma$ | t° | $\gamma$ | |
|---|---|---|---|---|
| 22.6 | 26.97 | 62.0 | 23.57 | VOGEL (1946) |
| 40.9 | 25.43 | 86.0 | 21.65 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.43143 | 1.43171 | 1.43389 | 1.43394 | 1.43824 | 1.43930 | 1.44245 | 1.44361 | BRUYLANTS |
| 30 | 1.42572 | 1.42608 | 1.42812 | 1.42828 | 1.43205 | 1.43345 | 1.43668 | 1.43787 | „ (unp.) |
| $\frac{dn}{dt}$ | 0.00038 | 39 | 38 | 38 | 41 | 39 | 38 | 38 | „ |
| 20 | — | 1.42980 | 1.43199 | — | — | 1.43734 | — | 1.44126 | VOGEL (1946) |

## *n*-HEXADECANE $n\text{-}C_{16}H_{34}$

**Constants**

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 137 | 5.3 | FRANCIS and WOOD (1926) | 156 | 13.8 | FRANCIS and WOOD (1926) |
| 145 | 9.0 | „ | 161.5 | 19.5 | „ |

*Freezing point*

| | | | |
|---|---|---|---|
| 18°11 | SMITH (1932) | 18°18 | RALSTON, HOERR and CREWS (1944) |
| 18°13 | CAREY and SMITH (1933) | 18°25 | KRAFFT (1886) |
| 18°145 | DEANESLY and CARLETON (1941) | | |

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.77335 | Deanesly and Carleton (1941) |
| 25.03 | 0.76991 | „ |
| 30 | 0.76667 | Bruylants (unp.) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | — | 1.43214 | 1.43435 | — | — | 1.43976 | — | — | Deanesly and Carleton (1941) |
| 25.03 | — | 1.43024 | 1.43247 | — | — | 1.43784 | — | — | |
| $\frac{dn}{dt}$ | — | 0.00038 | 38 | — | — | 38 | — | — | „ |
| 30 | 1.42834 | 1.42869 | 1.43084 | 1.43100 | 1.43479 | 1.43618 | 1.43957 | 1.44056 | Bruylants (unp.) |

## *n*-HEPTADECANE $n$-$C_{17}H_{36}$

**Constants**

*Melting point:* 21°72 Ralston, Hoerr and Crews (1944)

*Density:* 30° 0.77100 Bruylants (unp.)

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 30 | 1.43060 | 1.43092 | 1.43316 | 1.43325 | 1.43718 | 1.43844 | 1.44179 | 1.44275 | Bruylants (unp.) |

## *n*-OCTADECANE $n$-$C_{18}H_{38}$

Ubbelohde (1938) has carefully purified this product by molecular distillation.

*Melting point* and *heat of melting* Oldham and Ubbelohde (1940)

*Heat of combustion* Parks, West, Naylor, Fujii and MacClaine (1946)

Higher paraffins were prepared by Krafft (1882—86) and Eykman (1896—1919)

Nederbragt and Boelhouwer (1947) measured the densities and the viscosities of normal hydrocarbons in $C_{24}$, $C_{35}$, $C_{43}$; 2,2-dimethyldocosane ($C_{24}$); 10-nonylnonadecane ($C_{28}$); 7,12-dimethyl-9,10-di-*n*-hexyloctadecane ($C_{32}$).

Mazee (1948) has made a complete survey of normal hydrocarbons from $C_{21}$ to $C_{43}$ and of a series of their isomers.

## EICOSANE $n$-$C_{20}H_{42}$

*Melting point* KRAFFT (1882)
*Melting point, heat of melting* and *specific heat* PARKS, HUFFMAN and THOMAS (1930)
*Refractive index* EYKMAN (1896)

## DOCOSANE $n$-$C_{22}H_{46}$

*Melting point* KRAFFT (1882)
*Saturated vapour pressure* FRANCIS and WOOD (1926)

## TRICOSANE $n$-$C_{23}H_{48}$

**Constants** MAZEE (1948)
*Melting point* KRAFFT (1882)
*Refractive index* EYKMAN (1919)

## DOTRIACONTANE $n$-$C_{32}H_{66}$

Prepared from cetyl alcohol.

SEYER and MORRIS (1939) think that the presence of higher hydrocarbons raises the melting point.

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 69·65 | SEYER and MORRIS (1939) | 70°16 | RALSTON, HOERR and CREWS (1944) |
| 70·0 | DELCOURT (1931) and DEFFET (1935) | 70·2 | HILDEBRAND and WACHTER (1929) |

*Transition point*

| | | | |
|---|---|---|---|
| 63·5 | SEYER and MORRIS (1939) | 64·3 | DEFFET (1935) |

| *Melting curve* | | *Transition curve* | | |
|---|---|---|---|---|
| t° | p kg/cm² | t° | p kg/cm² | |
| 70.00 | 1 | 64.3 | 1 | DEFFET (1935) |
| 75.00 | 230 | 70.00 | 253 | „ |
| 80.00 | 455 | 75.00 | 474 | „ |
| 84.90 | 656 | 80.00 | 698 | „ |
| 89.80 | 870 | 85.00 | 922 | „ |
| 93.30 | 1015 | | | „ |

*Density and viscosity*

| t° | d | $\eta \cdot 10^5$ | |
|---|---|---|---|
| 75 | 0.77910 | 658 | DELCOURT (1931) |
| 100 | 0.76321 | 409 | „ |
| 118 | 0.75185 | — | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 11161.8 cal 15°/g | PARKS, WEST, NAYLOR, FIJII and MACCLAINE (1946) (M. W. 450.848) |

## B. ETHYLENIC HYDROCARBONS

These compounds have been studied far less than the saturated paraffins.

### ETHYLENE $C_2H_4$

*Preparation in the pure state*: By catalytic dehydration of the vapour of ethanol over calcined $Al_2O_3$ or by the action of concentrated sulphuric or phosphoric acid on ethyl alcohol (yields a less pure product) BATUECAS (1925).

**Constants. — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 9.50 | 50.65 | CARDOSO (1912) |
| 9.25 | 50.02 | KAY (1948) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|
| −145.07 | 0.62465 | — | −19.20 | 0.41313 | 0.051138 | MATHIAS, CROMMELIN and WATTS (1927) |
| −129.90 | 0.60449 | — | −14.18 | 0.39855 | 0.059942 | |
| −114.69 | 0.58380 | — | −10.93 | 0.38818 | 0.067215 | ,, |
| −103.01 | 0.56740 | — | − 7.70 | 0.37721 | 0.076050 | ,, |
| − 63.41 | 0.50588 | 0.012584 | + 5.84 | 0.30840 | 0.13266 | ,, |
| − 48.15 | 0.47822 | 0.020407 | 6.50 | 0.30342 | 0.13716 | ,, |
| − 37.13 | 0.45610 | 0.029465 | 7.98 | 0.28726 | 0.15268 | ,, |
| − 24.33 | 0.42655 | 0.041854 | | | | ,, |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −149.690 | 15.78 | −127.611 | 143.65 | −108.036 | 586.44 | EGAN and KEMP (1937) |
| −144.605 | 28.38 | −122.148 | 221.75 | −105.398 | 685.00 | ,, |
| −137.232 | 60.67 | −116.990 | 323.74 | −102.801 | 803.37 | ,, |
| −132.215 | 90.56 | −111.530 | 469.37 | | | ,, |
| −141.46 | 39.3 | −121.02 | 241.5 | — | — | HENNING and STOCK (1921) |
| −130.06 | 116.6 | −110.33 | 508.2 | — | — | ,, |
| −125.27 | 174.0 | −110.03 | 523.4 | −102.99 | 794.7 | KISTIAKOWSKY, ROMEYN JR., RUHOFF, SMITH and VAUGHAN (1935) |
| −118.24 | 296.2 | −104.85 | 714.4 | − 99.91 | 948.8 | |

| t° | p atm. | t° | p atm | t° | p atm. | |
|---|---|---|---|---|---|---|
| − 69.27 | 5.259 | − 30.53 | 188.51 | −7.54 | 33.923 | CROMMELIN and WATTS |
| − 60.90 | 7.206 | − 20.01 | 24.905 | 0.00 | 40.276 | ,, (1927) |
| − 52.09 | 9.774 | − 10.01 | 31.971 | +7.90 | 48.162 | ,, |
| − 41.01 | 13.907 | | | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| −103·7 | Stock (1923) | −103·72 | Henning and Stock (1921) |
| −103·7 | Egan and Kemp (1937) | −103·9 | Burrell and Robertson (1915) |

*Melting point*

| | | | |
|---|---|---|---|
| −169·5 | Eucken and Hauck (1928) | −169·50 | Kistiakowsky, Romeyn Jr., etc. (1935) |

*Triple point*

| | |
|---|---|
| −169°19 /0.001 atm. | Clusius and Weigand (1940) |

*Melting curve:* Clusius and Weigand (1940)

| t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|
| −169.19 | 0.001 | −168.52 | 47.1 | −167.96 | 85.5 |
| −169.07 | 8.6 | −168.37 | 57.2 | −167.86 | 93.15 |
| −168.94 | 17.4 | −168.23 | 66.8 | −167.85 | 93.5 |
| −168.81 | 26.8 | −168.11 | 75.9 | −167.84 | 94.9 |
| −168.66 | 36.8 | | | | |

*Isotherms*

From 1° to 20°; from 23 to 33 atm. Crommelin and Watts (1927)
From 0° to 150°; from 16 to 290 atm. Michels, Degruyter and Niesen (1936)
From 0° to 150°; until 3000 atm. Michels and Geldermans (1942)
In the critical region: Maass and Geddes (1936) and Dacey, Mac Intosh and Maass (1939).

*Weight of the normal litre in the gaseous state*

1.2603 Batuecas (1918)
1.26026 Stock and Ritter (1927) (corr. 1.26057, Stock and Ritter (1926)
1.26036 Moles, Toral and Escribano (1938)
$L_{.p} = (1.25122 \pm 0.000003) + 0.0091333\ p$

*Molecular weight in the gaseous state*

28.0556 Cawood and Patterson (1936)

*Coefficient of expansion*

from 25° to 50° at 760 mm: $3735 \cdot 10^{-6}$ Coppock and Whytlaw Gray (1934)

*Coefficient of compressibility*

from 0 to 1 atm. at 0°: $1 + \lambda = 1.00780$ Batuecas (1925)

## Heat constants

*Specific heat:* Rossini and Knowlton (1937)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −257.16 | 0.0286 | −225.87 | 0.2473 | L. −166.47 | 0.5890 | −121.28 | 0.5736 |
| −254.35 | 0.04634 | −220.64 | 0.2786 | −164.58 | 0.5883 | −114.61 | 0.5719 |
| −251.25 | 0.06853 | −215.56 | 0.3067 | −160.88 | 0.5861 | −108.93 | 0.5722 |
| −247.99 | 0.09118 | −210.36 | 0.3310 | −154.13 | 0.5826 | −104.45 | 0.5740 |
| −244.06 | 0.1199 | −204.75 | 0.3560 | −147.26 | 0.5808 | | |
| −240.00 | 0.1530 | −198.46 | 0.3849 | −140.56 | 0.5783 | | |
| −235.81 | 0.1850 | | | −133.08 | 0.5747 | | |
| −230.09 | 0.2156 | | | −127.78 | 0.5740 | | |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 12023.7 cal 15°/g | Rossini and Knolwton (1937) (M. W. 28.0512) |

*Other thermodynamic properties*

Michels, Geldermans and De Groot (1946) and Michels, De Groot and Geldermans (1947)

## PROPENE $CH_2=CH-CH_3$

## Constants

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 91.4 | 45.4 | 0.233 | Vaughan and Graves (1940) |
| 91.76 | 45.61 | 0.247 | Marchman, Prengle Jr. and Motard (1949) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −47.135 | 779.92 | −83.709 | 103.54 | Powell and Giauque (1939) |
| −52.932 | 598.30 | −88.674 | 73.19 | ,, |
| −59.817 | 425.47 | −93.209 | 52.32 | ,, |
| −65.765 | 309.96 | −96.695 | 39.92 | ,, |
| −70.493 | 237.31 | −100.439 | 29.41 | ,, |
| −77.577 | 154.52 | −107.396 | 15.98 | ,, |
| −37.73 | 1164.2 | −60.65 | 404.6 | Lamb and Roper (1940) |
| −45.58 | 834.2 | −74.69 | 183.4 | ,, |
| −50.64 | 662.8 | −88.08 | 75.75 | ,, |

| t° | p atm. | t° | p atm. | t° | p atm. | |
|---|---|---|---|---|---|---|
| 29.0 | 12.8 | 32.3 | 13.9 | 37.3 | 15.6 | Francis and Robbins |
| 29.1 | 12.9 | 35.2 | 14.9 | 39.1 | 16.4 | „ (1933) |
| 30.2 | 13.3 | 35.9 | 15.1 | 42.3 | 17.5 | „ |
| 31.4 | 13.5 | 36.0 | 15.2 | 44.0 | 18.2 | „ |
| | | | | 45.8 | 18.8 | „ |

*Densities of the liquid and the saturated vapour*

| t° | p atm. | L. | V. | |
|---|---|---|---|---|
| 0 | 5.75 | 0.590 | 0.0123 | Vaughan and Graves (1940) |
| 25 | 11.38 | 0.537 | 0.0246 | „ |
| 50 | 20.28 | 0.478 | 0.0458 | „ |
| 75 | 33.50 | 0.397 | 0.0890 | „ |
| 90 | 44.18 | 0.294 | 0.174 | „ |
| 91 | 45.08 | 0.277 | 0.189 | „ |
| 91.4 | 45.4 | 0.233 | 0.233 | „ |

*Boiling point*

| | |
|---|---|
| −47°67/759.1 mm | Ashdown, Harris and Armstrong (1936) |
| −47°75 | Powell and Giauque (1939) |
| −47°91/755 mm | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) |

*Melting point*

| | |
|---|---|
| −184°9 | Huffman, Parks and Barmore (1931) |
| −185°25 | Powell and Giauque (1939) |

*Weight of the litre in the gaseous state*

| | | |
|---|---|---|
| 0°/760 mm | 1.9149 | Batuecas (1934) |
| 0°/506.67 mm | 1.9021 | „ |
| 0°/380 mm | 1.8956 | „ |
| 25°/760 mm | 1.7461 | Powell and Giauque (1939) |

*Isotherms*: from 10 to 215 atm and from 30° to 250° Marchman, Prengle Jr. and Motard (1949)

*Specific heat:* Powell and Giauque (1939)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.98 | 0.0271 | −222.50 | 0.207 | L. −179.25 | 0.524 | −104.15 | 0.497 |
| −256.50 | 0.0378 | −217.20 | 0.224 | −174.50 | 0.518 | − 96.45 | 0.499 |
| −253.53 | 0.0526 | −211.91 | 0.244 | −168.98 | 0.511 | − 85.39 | 0.501 |
| −250.35 | 0.0725 | −206.55 | 0.261 | −163.28 | 0.508 | − 78.50 | 0.504 |
| −246.93 | 0.0926 | −201.71 | 0.276 | −157.52 | 0.503 | − 71.39 | 0.510 |
| −243.29 | 0.112 | −196.67 | 0.292 | −145.07 | 0.499 | − 63.98 | 0.513 |
| −239.54 | 0.133 | −196.57 | 0.295 | −138.60 | 0.498 | − 56.75 | 0.514 |
| −235.70 | 0.153 | −191.47 | 0.319 | −131.95 | 0.495 | − 49.76 | 0.520 |
| −231.87 | 0.171 | −188.29 | 0.339 | −118.19 | 0.496 | | |
| −227.63 | 0.187 | −186.99 | 0.383 | −111.28 | 0.496 | | |

Powell's sample seems pure but the curve $c_p/t°$ is rather irregular.

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | (B.P.) | 104.69 cal 15°/g | Powell and Giauque (1939) |
| *Heat of melting* | | 16.67 „ | Huffman, Parks and Barmore (1931) |
| | | 17.06 „ | Powell and Giauque (1939) |
| *Heat of combustion* | 25° ($c_p$) | 11688.6 „ | Rossini and Knowlton (1937) (M. W. 42.0768) |

## BUTENE-1 $CH_2=CH—CH_2—CH_3$

Prepared by dehydration of *normal* butyl alcohol by means of activated alumina.

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −56.75 | 64.12 | −7.47 | 727.5 | Lamb and Roper (1940) |
| −25.30 | 340.7 | −0.67 | 941.7 | „ |
| −22.91 | 378.3 | 0 | 964.1 | „ |
| −10.60 | 641.4 | | | „ |

*Boiling point:* −6°1 Grosse (1937)
−6°37 Kistiakowsky, Ruhoff, Smith and Vaughan (1935)

*Specific heat:* Todd and Parks (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| L. −191.86 | 0.4736 | −155.16 | 0.4521 | −97.46 | 0.4572 | −49.96 | 0.4827 |
| −186.36 | 0.4684 | −138.66 | 0.4505 | −91.26 | 0.4590 | −44.16 | 0.4864 |
| −180.36 | 0.4634 | −130.66 | 0.4505 | −85.16 | 0.4621 | −38.36 | 0.4923 |
| −176.46 | 0.4607 | −124.16 | 0.4514 | −77.36 | 0.4670 | −32.56 | 0.4959 |
| −170.96 | 0.4575 | −117.76 | 0.4522 | −71.16 | 0.4706 | −25.36 | 0.5016 |
| −164.56 | 0.4558 | −109.86 | 0.4539 | −55.96 | 0.4788 | −19.76 | 0.5076 |

## BUTENES-2 $CH_3-CH=CH-CH_3$

The butenes-2 are prepared by dehydration, with concentrated sulphuric acid, of *secondary* butyl alcohol. They are purified by fractional distillation.

### *Cis*-BUTENE-2

**Constants**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −86.90 | 3.71 | −14.66 | 361.2 | | | Lamb and Roper (1940) |
| −53.21 | 45.44 | −13.79 | 373.7 | | | ,, |
| −47.49 | 64.73 | 0 | 658.3 | | | ,, |
| −43.05 | 83.79 | + 2.87 | 749.7 | | | ,, |
| −33.65 | 141.2 | 9.60 | 951.5 | | | ,, |
| −78.14 | 5.70 | 0.01 | 658.90 | | | Kistiakowsky, Ruhoff, Smith and Vaughan |
| −47.21 | 64.65 | 24.38 | 1572.90 | | | ,, (1935) |
| −21.04 | 265.45 | | | | | |
| −70.090 | 13.09 | −23.129 | 240.04 | 6.702 | 850.50 | Scott, Ferguson and Brickwedde (1944) |
| −62.548 | 23.15 | −14.822 | 353.25 | 11.144 | 1000.27 | |
| −55.370 | 38.29 | − 6.716 | 501.46 | 15.520 | 1167.07 | ,, |
| −48.117 | 61.12 | − 6.706 | 501.51 | 19.855 | 1354.53 | ,, |
| −40.075 | 98.58 | + 0.56 | 672.53 | 22.759 | 1489.85 | ,, |
| −31.547 | 157.18 | 3.689 | 759.14 | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 3°21 | Lamb and Roper (1940) | 3°73 | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) |
| 3°717 | Scott, Ferguson and Brickwedde (1944) | | |

*Melting point*

| | | | |
|---|---|---|---|
| −138°910 | Glasgow Jr., Krouskop, Beadle, Axilbrod and Rossini (1948) | −139°3 | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) |
| | | −139°36 | Todd and Parks (1936) |

*Triple point*

| | |
|---|---|
| −138°900 | Scott, Ferguson and Brickwedde (1944) |

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|
| C. | −179.56 | 0.2613 | −99.16 | 0.4711 | Todd and Parks |
| | −174.46 | 0.2722 | −93.16 | 0.4704 | „ (1936) |
| | −172.66 | 0.2747 | −80.96 | 0.4717 | „ |
| | −166.16 | 0.2887 | −74.96 | 0.4731 | „ |
| | −162.96 | 0.2930 | −61.96 | 0.4756 | „ |
| | −159.36 | 0.3011 | −54.96 | 0.4782 | „ |
| | −156.66 | 0.3064 | −48.56 | 0.4800 | „ |
| | −150.96 | 0.3168 | −42.16 | 0.4828 | „ |
| L. | −134.96 | 0.4803 | −29.66 | 0.4895 | „ |
| | −128.16 | 0.4766 | −23.56 | 0.4932 | „ |
| | −120.36 | 0.4737 | −17.86 | 0.4970 | „ |
| | −111.36 | 0.4716 | −12.16 | 0.5021 | „ |
| | −105.36 | 0.4711 | − 6.56 | 0.5064 | „ |
| C. | −268.16 | 0.000509 | −103.16 | 0.47427 | Scott, Ferguson and Brickwedde (1944) (M. W. 56.104) |
| | −263.16 | 0.004071 | −93.16 | 0.47333 | |
| | −253.16 | 0.02857 | −83.16 | 0.47372 | „ |
| | −243.16 | 0.06722 | −73.16 | 0.47491 | „ |
| | −233.16 | 0.10747 | −63.16 | 0.47690 | „ |
| | −223.16 | 0.14371 | −53.16 | 0.48003 | „ |
| | −213.16 | 0.17618 | −43.16 | 0.48440 | „ |
| | −203.16 | 0.20441 | −33.16 | 0.48966 | „ |
| | −193.16 | 0.22953 | −23.16 | 0.49556 | (Values at other temperatures: see authors) |
| | −183.16 | 0.25301 | −13.16 | 0.50243 | |
| | −173.16 | 0.27447 | − 3.16 | 0.51031 | |
| | −163.16 | 0.29520 | + 1.84 | 0.51464 | „ |
| | −153.16 | 0.31642 | 11.84 | 0.52380 | „ |
| | −143.16 | 0.33858 | 21.84 | 0.53391 | „ |
| L. | −123.16 | 0.47893 | 25.00 | 0.53737 | „ |
| | −113.16 | 0.47625 | 26.84 | 0.53938 | „ |

| *Heat of vaporisation* | t° | cal 15°/g | t° | cal 15°/g | |
|---|---|---|---|---|---|
| | −26.98 | 106.13 | −0.80 | 100.42 | Scott, Ferguson and Brickwedde (1944) |
| | −20.72 | 105.07 | +6.54 | 98.841 | |
| | − 9.87 | 102.54 | 19.09 | 95.750 | ,, |

| *Heat of melting* | 31.17 | cal 15°/g | Todd and Parks (1936) |
|---|---|---|---|
| | 32.2969 | ,, | Scott, Ferguson and Brickwedde (1944) |

## *Trans*-BUTENE-2

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −68.40 | 18.46 | −33.65 | 163.7 | − 6.96 | 559.5 | Lamp and Roper (1940) |
| −53.21 | 53.45 | −22.23 | 287.4 | 0 | 733.7 | ,, |
| −47.49 | 75.78 | −14.66 | 403.1 | 2.87 | 820.2 | ,, |
| −43.05 | 97.94 | −13.79 | 419.9 | 9.60 | 1047.9 | ,, |
| | | | | | | ,, |
| −77.96 | 8.75 | −21.05 | 302.30 | 20.56 | 1521.65 | Kistiakowski, Ruhoff, |
| −47.20 | 76.60 | + 0.01 | 733.75 | 24.53 | 1729.30 | Smith and Vaughan |
| −46.89 | 78.05 | 19.94 | 1400.65 | — | — | ,, (1935) |
| −71.457 | 14.92 | −37.359 | 134.51 | −9.958 | 492.86 | Guttman and Pitzer |
| −60.543 | 32.76 | −28.303 | 214.37 | −3.827 | 630.38 | ,, (1945) |
| −51.018 | 60.64 | −21.001 | 303.58 | +0.982 | 762.97 | ,, |
| −42.899 | 98.83 | −14.259 | 410.47 | | | ,, |

*Boiling point*

| | |
|---|---|
| 0°884 | Guttman and Pitzer (1945) |
| 0°96 | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) |

*Melting point*

| | | | |
|---|---|---|---|
| − 105.55 | Guttman and Pitzer (1945) | −105.8 | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) |
| − 105.550 | Glasgow Jr., Krouskop, Beadle, Axilbrod and Rossini (1948) | | |

*Specific heat:* Todd and Parks (1936)

| t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|
| C. −179.56 | 0.2462 | L. −97.16 | 0.4703 |
| −174.06 | 0.2592 | −90.66 | 0.4722 |
| −167.46 | 0.2741 | −57.46 | 0.4883 |
| −147.26 | 0.3225 | −51.36 | 0.4920 |
| −138.96 | 0.3433 | −19.56 | 0.5141 |
| | | −13.56 | 0.5199 |

## *Iso*-BUTENE or 2-METHYLPROPENE-1 $CH_2=C(CH_3)_2$

The *iso*-butene is obtained very pure by dehydration of *tertiary* butylalcohol and fractionation of the product.

### Constants

*Critical constants*

| t° cr. | p cr atm. | d cr. | |
|---|---|---|---|
| 144°73 | 39.48 | 0.234 | Beattie, Ingersoll and Stockmayer (1942) |

*Saturated vapour pressure*

| t° | p atm. | | t° | p mm | |
|---|---|---|---|---|---|
| 30 | 3.444 | Beattie, Ingersoll and | −56.75 | 65.44 | Lamb and Roper (1940) |
| 50 | 5.976 | Stockmayer (1942) | −25.30 | 357.8 | „ |
| 75 | 10.86 | „ | −20.88 | 431.0 | „ |
| 100 | 18.08 | „ | − 7.47 | 748.5 | „ |
| 125 | 28.41 | „ | − 0.67 | 966.0 | „ |
| | | „ | 0 | 987.8 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| −6°6 | Grosse (1937) | −7°0 | Lamb and Roper (1940) |
| −7°0 | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) | | |

*Melting point*

| | | | |
|---|---|---|---|
| −140°350 | Glasgow Jr., Krouskop, Beadle, Axilbrod and Rossini (1948) | −140°7 | Kistiakowsky, Ruhoff, Smith and Vaughan (1935) |
| | | −140°7 | Todd and Parks (1936) |

*Isotherms* in the critical region: Beattie, Ingersoll and Stockmayer (1942)

*Specific heat:* Todd and Parks (1936)

| t | $c_p$ | t | $c_p$ | t | $c_p$ | t | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −179.86 | 0.2498 | L. −133.96 | 0.4547 | −100.26 | 0.4650 | −45.26 | 0.4970 |
| −174.36 | 0.2614 | −127.96 | 0.4564 | − 93.36 | 0.4681 | −34.16 | 0.5037 |
| −167.66 | 0.2749 | −121.16 | 0.4579 | − 86.66 | 0.4715 | −30.46 | 0.5089 |
| −160.86 | 0.2898 | −114.06 | 0.4600 | − 62.92 | 0.4860 | −25.16 | 0.5133 |
| −154.26 | 0.3056 | −107.06 | 0.4621 | − 56.96 | 0.4896 | −20.06 | 0.5173 |

| | | |
|---|---|---|
| *Heat of melting* | 25.25 cal 15°/g | Todd and Parks (1936) |

## PENTENE-1 $CH_2=CH-CH_2-CH_2-CH_3$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −0.159 | 233.72 | 24.834 | 633.99 | 45.614 | 1268.0 | Scott, Waddington, |
| +4.751 | 289.13 | 29.967 | 760.00 | 50.914 | 1489.1 | Smith and Huffman |
| 9.706 | 355.22 | 35.142 | 906.06 | 56.253 | 1740.8 | (1949) |
| 14.704 | 433.56 | 40.359 | 1074.6 | 61.641 | 2026.0 | ,, |
| 19.750 | 525.86 | | | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 29.9 | Kazanskii, Liberman, Plate, Rosengart and Tarassova (1947) | 29.967 | Scott, Waddington, Smith and Huffman (1949) |
| | | 30.08 | Geldof and Wibaut (1948) |

*Melting point:* −166.222 Todd, Oliver and Huffman (1947)

*Density*

| t° | d | |
|---|---|---|
| 15 | 0.6458 | Wibaut and Geldof (1946) |
| 20 | 0.6406 | ,, |
| 20 | 0.6411 | Kazanskii, Liberman, etc. (1947) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He (4713) | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.3721 | 1.3725 | 1.3748 | 1.3748 | 1.3795 | 1.3806 | 1.3819 | 1.3842 | 1.3856 | Wibaut and Geldof |
| 20 | 1.3690 | 1.3694 | 1.3716 | 1.3717 | 1.3763 | 1.3774 | 1.3787 | 1.3810 | 1.3823 | ,, (1946) |
| $\frac{dn}{dt}$ | 0.0006 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | ,, |
| 20 | — | — | 1.3719 | — | — | — | — | — | — | Kazanskii, etc. (1947) |

*Specific heat:* Todd, Oliver and Huffman (1947) (M.W. 70.130)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.44 | 0.012 | −231.38 | 0.118 | L. −138.04 | 0.4386 | −52.69 | 0.4661 |
| −258.63 | 0.0170 | −225.06 | 0.137 | −127.96 | 0.4396 | −44.72 | 0.4705 |
| −257.86 | 0.0194 | −218.51 | 0.1551 | −117.99 | 0.4409 | −43.65 | 0.4718 |
| −256.49 | 0.0238 | −212.10 | 0.1706 | −108.12 | 0.4426 | −34.65 | 0.4773 |
| −253.94 | 0.0327 | −211.30 | 0.1723 | − 98.36 | 0.4453 | −33.90 | 0.4782 |
| −253.88 | 0.0332 | −205.22 | 0.1855 | − 88.69 | 0.4483 | −28.76 | 0.4816 |
| −250.29 | 0.0474 | −204.77 | 0.1867 | − 78.18 | 0.4528 | −23.26 | 0.4859 |
| −249.17 | 0.0521 | −197.69 | 0.2029 | − 71.19 | 0.4557 | −18.34 | 0.4898 |
| −246.21 | 0.0639 | −189.88 | 0.2176 | − 66.87 | 0.4577 | − 8.07 | 0.4982 |
| −243.48 | 0.0743 | −181.60 | 0.2330 | − 61.84 | 0.4605 | + 2.02 | 0.5069 |
| −242.01 | 0.0803 | | | − 55.61 | 0.4639 | 11.95 | 0.5166 |
| −237.50 | 0.0972 | | | | | 22.12 | 0.5262 |

| *Heat of melting* | 19.81 cal 15°/g | Todd, Oliver and Huffman (1947) |
|---|---|---|

## *Cis*-PENTENE-2 $CH_3-CH=CH-CH_2-CH_3$

**Constants:** Todd, Oliver and Huffman (1947)

*Melting point:* −151°359

*Specific heat:* (M.W 70.130).

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −259.65 | 0.0117 | −170.26 | 0.25791 | − 85.60 | 0.4492 | −13.10 | 0.4845 |
| −249.60 | 0.04322 | −162.23 | 0.27551 | − 74.88 | 0.4518 | − 1.15 | 0.4939 |
| −230.86 | 0.1116 | −156.81 | 0.29506 | − 64.26 | 0.4549 | + 5.55 | 0.4993 |
| −218.07 | 0.15070 | L. −144.47 | 0.4544 | − 53.76 | 0.4595 | 8.77 | 0.5020 |
| −209.49 | 0.17360 | −129.86 | 0.4499 | − 43.41 | 0.4642 | 13.49 | 0.5063 |
| −198.93 | 0.19828 | −119.54 | 0.4485 | − 33.16 | 0.4702 | 15.43 | 0.5085 |
| −191.95 | 0.21390 | −109.50 | 0.4474 | − 23.05 | 0.4772 | 22.11 | 0.5144 |
| −181.36 | 0.23593 | − 96.40 | 0.4480 | (Values at other temperatures: see authors) | | | |

| | | |
|---|---|---|
| *Heat of melting* | 24.254 cal 15°/g | Todd, Oliver and Huffman (1947) |
| *Heat of combustion* | 25° ($c_p$) 11366.9 „ | Coops, Mulder, Dienske and Smittenberg (1946) (M. W. 70.130) |

## *Trans*-PENTENE-2 $CH_3-CH=CH-CH_2-CH_3$

**Constants**: Todd, Oliver and Huffman (1947)

*Freezing point*

| | |
|---|---|
| −140°248 | Streiff, Murphy, Sedlak, Willingham and Rossini (1946) |
| −140°21 | Todd, Oliver and Huffman (1947) |

*Specific heat*: (M.W. 70.130)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.39 | 0.00875 | −215.01 | 0.15203 | L. −138.18 | 0.43493 | −68.69 | 0.46172 |
| −258.37 | 0.0134 | −213.08 | 0.15691 | −132.57 | 0.43647 | −65.02 | 0.46399 |
| −256.45 | 0.01855 | −208.91 | 0.16811 | −129.70 | 0.43734 | −53.91 | 0.47019 |
| −254.71 | 0.02399 | −201.31 | 0.18620 | −120.89 | 0.43961 | −42.93 | 0.47742 |
| −251.48 | 0.03466 | −195.12 | 0.19994 | −118.21 | 0.44078 | −32.35 | 0.48489 |
| −248.64 | 0.04475 | −191.49 | 0.20731 | −115.07 | 0.44140 | −21.51 | 0.49335 |
| −247.52 | 0.04859 | −189.00 | 0.21336 | −108.26 | 0.44366 | −11.08 | 0.50181 |
| −242.70 | 0.06575 | −184.11 | 0.22335 | −103.21 | 0.44569 | − 0.85 | 0.51116 |
| −237.59 | 0.08400 | −176.24 | 0.23804 | − 98.44 | 0.44715 | + 7.36 | 0.51824 |
| −232.26 | 0.10172 | −167.99 | 0.25259 | − 91.54 | 0.45033 | 9.31 | 0.51920 |
| −226.50 | 0.1197 | −159.46 | 0.26745 | − 87.78 | 0.45187 | 15.58 | 0.52580 |
| −220.76 | 0.1364 | | | − 80.03 | 0.45548 | 22.90 | 0.53290 |
| −218.46 | 0.14273 | | | − 76.32 | 0.45786 | 28.52 | 0.53849 |

| | | |
|---|---|---|
| *Heat of melting* | 28.483 cal 15°/g | Todd, Oliver and Huffman (1947) |
| *Heat of combustion* | 25° ($c_p$) 11364.3 „ | Coops, Mulder, Dienske and Smittenberg (1946) (M. W. 70.130) |

## 2-METHYLBUTENE-1 $CH_2=C(CH_3)-CH_2-CH_3$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 1.155 | 233.72 | 26.062 | 633.99 | 46.728 | 54.399 | Scott, Waddington, Smith and Huffman (1949) |
| 6.054 | 289.13 | 31.162 | 760.00 | 52.005 | 59.753 | |
| 10.993 | 355.22 | 36.308 | 906.06 | 57.320 | 65.151 | |
| 15.973 | 433.56 | 41.500 | 1074.6 | 62.675 | 70.590 | |
| 20.996 | 525.86 | | | | | |

*Boiling point:* 31°162 Scott, Waddington, Smith and Huffman (1949)

*Freezing point*

| | |
|---|---|
| −137°54 | Todd, Oliver and Huffman (1947) |
| −137°582 | Streiff, Murphy, Sedlak, Willingham and Rossini (1946) |

*Specific heat:* Todd, Oliver and Huffman (1947) (M.W. 70.130)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.47 | 0.0118 | −229.64 | 0.1167 | −182.10 | 0.22218 | −86.76 | 0.46052 |
| −258.70 | 0.01682 | −225.44 | 0.1278 | −178.32 | 0.22849 | −75.87 | 0.46461 |
| −256.66 | 0.02362 | −218.77 | 0.14412 | −174.53 | 0.23427 | −65.11 | 0.46930 |
| −254.12 | 0.03289 | −217.34 | 0.14744 | −166.45 | 0.24130 | −54.49 | 0.47455 |
| −253.90 | 0.03410 | −214.72 | 0.15969 | −163.13 | 0.24686 | −44.01 | 0.48064 |
| −250.70 | 0.04613 | −211.85 | 0.16831 | −155.63 | 0.26445 | −33.67 | 0.48712 |
| −246.39 | 0.06257 | −207.77 | 0.17410 | L. −129.25 | 0.45347 | −23.48 | 0.49438 |
| −243.93 | 0.07140 | −204.83 | 0.18392 | −125.04 | 0.45377 | −13.44 | 0.50198 |
| −242.10 | 0.07764 | −199.74 | 0.18842 | −112.21 | 0.45487 | − 2.75 | 0.51095 |
| −238.01 | 0.09179 | −197.31 | 0.20298 | −108.94 | 0.45509 | + 8.58 | 0.52055 |
| −231.85 | 0.1106 | −189.62 | 0.21122 | − 98.72 | 0.45705 | 19.70 | 0.53075 |

(Values at other temperatures: see authors)

*Heat of melting:* 26.978 cal 15°/g Todd, Oliver and Huffman (1947)

## 3-METHYLBUTENE-1 or *Iso*-PROPYLETHYLENE $CH_2=CH-CH(CH_3)_2$

**Constants:** Todd, Oliver and Huffman (1947)

*Melting point:* −168°44

*Specific heat:* (M.W. 70.130)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.24 | 0.01829 | −217.44 | 0.14499 | −147.74 | 0.41607 | −37.06 | 0.47345 |
| −256.20 | 0.02473 | −212.66 | 0.15546 | −139.50 | 0.41817 | −26.41 | 0.48254 |
| −254.12 | 0.03191 | −204.71 | 0.17184 | −130.33 | 0.42092 | −15.94 | 0.49117 |
| −250.00 | 0.04718 | −203.85 | 0.17361 | −120.09 | 0.42451 | − 6.50 | 0.49922 |
| −246.01 | 0.06203 | −196.54 | 0.18756 | −110.00 | 0.42842 | + 0.32 | 0.50581 |
| −243.66 | 0.07040 | −195.84 | 0.18882 | −100.06 | 0.43340 | 7.87 | 0.51325 |
| −241.66 | 0.07740 | −188.28 | 0.20350 | − 89.78 | 0.43831 | 16.61 | 0.52274 |
| −237.34 | 0.09191 | −187.07 | 0.20547 | − 79.18 | 0.44489 | 25.19 | 0.53209 |
| −230.92 | 0.1112 | −180.77 | 0.21650 | −68.64 | 0.45037 | (Values at other temperatures: see authors) | |
| −224.30 | 0.1288 | −173.74 | 0.22928 | −58.46 | 0.45735 | | |
| −218.98 | 0.1415 | L. −155.21 | 0.41460 | −47.89 | 0.46519 | | |

*Heat of melting:* 18.278 cal 15°/g

## 2-METHYLBUTENE-2 $CH_3-C(CH_3)=CH-CH_3$

### Constants

*Saturated vapour pressure:* Scott, Waddington, Smith and Huffman (1949)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 3.042 | 187.57 | 23.103 | 433.56 | 43.806 | 906.06 | 59.753 | 1489.1 |
| 8.008 | 233.72 | 28.220 | 525.86 | 49.078 | 1074.6 | 65.151 | 1740.8 |
| 12.987 | 289.13 | 33.373 | 633.99 | 54.399 | 1268.0 | 70.590 | 2026.0 |
| 18.033 | 355.22 | 38.567 | 760.00 | | | | |

*Boiling point:* 38°567 Scott, Waddington, Smith and Huffman (1949)

*Freezing point*

| | |
|---|---|
| −133°74 | Todd, Oliver and Huffman (1947) |
| −133°792 | Streiff, Murphy, Sedlak, Willingham and Rossini (1946) |

*Specific heat:* Todd, Oliver and Huffman (1947) (M.W. 70.130)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.67 | 0.02146 | −212.59 | 0.01473 | −145.94 | 0.30675 | − 69.49 | 0.46001 |
| −256.39 | 0.03057 | −205.87 | 0.18350 | L. −132.26 | 0.45061 | −58.84 | 0.46385 |
| −253.71 | 0.04406 | −199.01 | 0.19927 | −123.37 | 0.45051 | −48.32 | 0.46844 |
| −249.98 | 0.05973 | −192.80 | 0.21358 | −117.05 | 0.45029 | −37.92 | 0.47426 |
| −245.80 | 0.07381 | −190.35 | 0.21875 | −113.15 | 0.45009 | −27.66 | 0.48030 |
| −242.00 | 0.09128 | −186.81 | 0.22748 | −107.64 | 0.45070 | −17.54 | 0.48738 |
| −237.21 | 0.1119 | −182.27 | 0.23641 | −101.08 | 0.45157 | − 7.56 | 0.49408 |
| −231.08 | 0.1315 | −180.03 | 0.24123 | − 98.13 | 0.45215 | + 2.27 | 0.50141 |
| −224.78 | 0.14306 | −172.71 | 0.25491 | − 91.12 | 0.45378 | 11.97 | 0.50899 |
| −220.85 | 0.14940 | −164.12 | 0.27079 | − 89.16 | 0.45420 | 20.74 | 0.51686 |
| −218.61 | 0.16393 | −155.88 | 0.28638 | − 80.25 | 0.45642 | 27.82 | 0.52243 |
| −213.31 | 0.16593 | −148.08 | 0.30151 | (Values at other temperatures: see authors) | | | |

*Heat of melting:* 25.911 cal 15° g Todd, Oliver and Huffman (1947)

## HEXENE-1 $CH_2=CH-(CH_2)_3-CH_3$

Prepared by the action of allyl bromide on propylmagnesium bromide.

**Constants**

*Boiling point*

| | | | |
|---|---|---|---|
| 63°35 | Van Risseghem (1926) | 63°5 | Geldof and Wibaut (1948) |

*Freezing point:* −139° Van Risseghem (1926)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.6925 | Van Risseghem (1926) | 20 | 0.6736 | Wibaut and Geldof |
| 15 | 0.67875 | „ | 25 | 0.6689 | „ (1946) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He (4713) | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 14.9 | 1.3881 | 1.3885 | — | 1.3909 | 1.39545 | 1.3967 | — | — | 1.40155 | Van Risseghem (1926) |
| 20 | 1.3855 | 1.3858 | 1.3881 | 1.3882 | 1.3929 | 1.3940 | 1.3953 | 1.3976 | 1.3990 | Wibaut and |
| 25 | — | 1.3830 | 1.3853 | 1.3854 | 1.3901 | 1.3911 | 1.3924 | 1.3947 | 1.3962 | Geldof (1946) |
| $\frac{dn}{dt}$ | | 0.00056 | 56 | 56 | 56 | 58 | 58 | 58 | 56 | „ |

## A. 3-METHYLPENTENE-2(α) B. 3-METHYLPENTENE-2 (β)

$CH_3-CH=C(CH_3)-CH_2-CH_3$

**Constants**: Howard, Mears, Fookson, Pomerantz and Brooks (1947)

| | | A | B | |
|---|---|---|---|---|
| *Boiling point* | | 67°8 | 70°5 | Howard, Mears, etc. (1947) |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°39 | 0°37 | „ |
| *Freezing point* | | −135°4 | −138°5 | „ |
| | | — | −138°445 | Streiff, Zimmerman, Soule, Butt, Sedlak, Willingham and Rossini (1948) |
| *Density* | 20° | 0.6942 | 0.6986 | Howard, Mears, etc. (1947) |
| | 25° | 0.6898 | 0.6942 | „ |
| *Refractive index* | $n_D^{20°}$ | 1.4016 | 1.4045 | „ |
| | $n_D^{25°}$ | 1.3989 | 1.4018 | „ |
| | $\frac{dn}{dt}$ | 0.00054 | 0.00054 | „ |

## 2,3-DIMETHYLBUTENE-1 $CH_2=C(CH_3)-CH(CH_3)-CH_3$

**Constants**

*Boiling point*

| | | | |
|---|---|---|---|
| 55°615 | $\frac{dt}{dp}$ *(10 mm)* | 0°410 | Brooks, Howard and Crafton (1940) |
| 55·641 | „ | 0°429 | Howard, Mears, Fookson, Pomerantz and Brooks (1947) |

*Freezing point:* −140°1 Brooks, Howard and Crafton (1940)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 0.67801 | Brooks, Howard and Craf- | 20 | 0.67792 | Howard, Mears, etc. (1947) |
| 25 | 0.67322 | „ ton (1940) | 25 | 0.67312 | „ |

*Refractive index*

| t° | $n_D$ | | t° | $n_D$ | |
|---|---|---|---|---|---|
| 20 | 1.39022 | Brooks, Howard and Craf- | 20 | 1.39044 | Howard, Mears, etc. (1947) |
| 25 | 1.38724 | „ ton (1940) | 25 | 1.38745 | „ |
| $\frac{dn}{dt}$ | 0.000596 | „ | $\frac{dn}{dt}$ | 0.00060 | „ |

## 3,3-DIMETHYLBUTENE-1 $CH_2=CH-C(CH_3)_2-CH_3$

**Constants:** Brooks, Howard and Crafton (1940)

*Boiling point*

| | |
|---|---|
| 41°239 | $\frac{dt}{dp}$ *(10 mm):* 0°397 |

*Freezing point*

| | |
|---|---|
| −115·20 | Streiff, Murphy, Zimmerman, Soule, Sedlak, Willingham and Rossini (1947) |
| −115°53 | Brooks, Howard and Crafton (1940) |

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.65293 | Brooks, Howard and Crafton (1940) |
| 25 | 0.64786 | ,, |

*Refractive index*

| $n_D^{20°}$ | 1.37604 | $n_D^{25°}$ | 1.37295 | $\frac{dn}{dt}$ 0.000618 |
|---|---|---|---|---|

## 2,3-DIMETHYLBUTENE-2 $CH_3-C(CH_3)=C(CH_3)-CH_3$

**Constants:** Howard, Mears, Fookson, Pomerantz and Brooks (1947)

*Boiling point*

| | | | |
|---|---|---|---|
| 73°206 | $\frac{dt}{dp}$ *(10 mm)* | 0°424 | Howard, Mears, etc. (1947) |
| 73°24 | ,, | 0°414 | Brooks, Howard and Crafton (1940) |

*Freezing point:* −74°30

*Density* *Refractive index*

| t° | d | t° | $n_D$ | |
|---|---|---|---|---|
| 20 | 0.70795 | 20 | 1.41221 | Howard, Mears, etc. (1947) |
| 25 | 0.70336 | 25 | 1.40944 | ,, |
| | | $\frac{dn}{dt}$ | 0.00055 | ,, |

## TETRAMETHYLETHYLENE $(CH_3)_2C=C(CH_3)_2$

Prepared by dehydration of dimethyl-*iso*-propylcarbinol by means of sulphuric acid.

**Constants**

*Boiling point* *Freezing point*

| | | | |
|---|---|---|---|
| 73°30 | Kistiakowsky, Ruhoff, Smith and Vaughan (1936) | −74°2 | Kistiakowsky, Ruhoff, Smith and Vaughan (1936) |
| | | −74°6 | Parks, Todd and Shomate (1936) |

*Refractive index*

| $n_D^{20°}$ | 1.4124 | Kistiakowsky, Ruhoff, Smith and Vaughan (1936) |
|---|---|---|

*Specific heat:* Parks, Todd and Shomate (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −190.56 | 0.2222 | −141.56 | 0.3089 | L. −70.76 | 0.4395 | −26.86 | 0.4605 |
| −185.66 | 0.2330 | −132.46 | 0.3220 | −63.36 | 0.4412 | − 9.26 | 0.4722 |
| −179.36 | 0.2461 | −124.56 | 0.3340 | −58.56 | 0.4430 | + 3.84 | 0.4829 |
| −171.96 | 0.2596 | −116.86 | 0.3453 | −46.36 | 0.4492 | 9.64 | 0.4877 |
| −165.06 | 0.2709 | −108.46 | 0.3610 | −40.36 | 0.4522 | 18.04 | 0.4955 |
| −158.16 | 0.2824 | −101.56 | 0.3774 | −31.26 | 0.4570 | 22.34 | 0.4991 |
| −150.16 | 0.2939 | | | | | | |

| | | |
|---|---|---|
| *Heat of melting* | 15.51 cal 15°/g | Parks, Todd and Shomate (1936) |

## HEPTENE-1 $CH_2=CH-(CH_2)_4-CH_3$

Prepared by the action of allyl bromide on butylmagnesium bromide.

### Constants

*Boiling point*

| | |
|---|---|
| 93°19 | Kistiakowsky, Ruhoff, Smith and Vaughan (1936) |
| 93°6 | Geldof and Wibaut (1948) |

*Freezing point*

| | |
|---|---|
| −119°1 | Kistiakowsky, Ruhoff, Smith and Vaughan (1936) |
| −119°7 | Parks, Todd and Shomate (1936) |

*Density:* 20° 0.6972; 25° 0.6929 Wibaut and Geldof (1946)

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He (4737) | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 1.3972 | 1.3975 | 1.3999 | 1.3999 | 1.4046 | 1.4058 | 1.4071 | 1.4094 | 1.4108 | Wibaut and Geldof (1946) |
| 25 | 1.3946 | 1.3950 | 1.3973 | 1.3973 | 1.4020 | 1.4032 | 1.4045 | 1.4068 | 1.4082 | " |
| $\frac{dn}{dt}$ | 0.00052 | 50 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | " |
| 20 | — | — | 1.3997 | — | — | — | — | — | — | Kistiakowsky, Ruhoff, etc. (1936) |

*Specific heat:* PARKS, TODD and SHOMATE (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −192.76 | 0.1841 | −144.66 | 0.2518 | −86.96 | 0.4436 | −30.66 | 0.4719 |
| −187.56 | 0.1922 | −137.36 | 0.2617 | −76.26 | 0.4485 | −16.36 | 0.4819 |
| −181.36 | 0.2017 | −130.46 | 0.2726 | −71.26 | 0.4515 | −11.96 | 0.4855 |
| −174.96 | 0.2120 | L. −122.06 | 0.4383 | −58.06 | 0.4557 | + 1.74 | 0.4983 |
| −168.16 | 0.2215 | −113.36 | 0.4387 | −53.66 | 0.4588 | 7.24 | 0.5033 |
| −160.86 | 0.2317 | − 98.36 | 0.4400 | −38.96 | 0.4656 | 14.44 | 0.5092 |
| −152.06 | 0.2436 | − 92.06 | 0.4421 | −34.86 | 0.4695 | 22.04 | 0.5181 |

| | | |
|---|---|---|
| *Heat of melting* | 30.82 cal 15°/g | PARKS, TODD and SHOMATE (1936) |
| *Heat of combustion* | 25° ($c_p$) 11317.5 „ | COOPS, MULDER, DIENSKE and SMITTENBERG (1946) (M. W. 98.182) |

## 2,3,3-TRIMETHYLBUTENE-1: $CH_2=C(CH_3)-C(CH_3)_3$

Prepared by dehydration of pentamethylethanol, by means of paratoluene sulphonic acid. CHAVANNE and VAN RISSEGHEM (1922); CHAVANNE and LEJEUNE (1922)

### Constants

*Boiling point*

| | | |
|---|---|---|
| 78° | | CHAVANNE, etc. (1922) |
| 78°874 | $\frac{dn}{dt}$ *(10 mm)*: 0°447 | BROOKS, HOWARD and CRAFTON (1940) |

*Freezing point*

| | |
|---|---|
| −110°2 | CHAVANNE, etc. (1922) |
| −111°40 | BROOKS, HOWARD and CRAFTON (1940) |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 35°2 | CHAVANNE, etc. (1922) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.7235 | CHAVANNE, etc. (1922) | 20 | 0.70501 | BROOKS, HOWARD and CRAFTON (1940) |
| 15 | 0.7101 | „ | 25 | 0.70054 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 0 | 627 | 25 | 445 | CHAVANNE, etc. (1922) |
| 15 | 509 | 30 | 421 | ,, |
| 20 | 480 | | | ,, |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.4032 | 1.4059 | 1.4119 | 1.4164 | CHAVANNE etc. (1922) |
| 20 | — | 1.40292 | — | — | BROOKS, HOWARD and CRAFTON (1940) |
| 25 | — | 1.40004 | — | — | ,, |
| $\frac{dn}{dt}$ | — | 0.000576 | — | — | ,, |

## 3-ETHYLPENTENE-2 $CH_3-CH=C(C_2H_5)-CH_2-CH_3$

**Constants:** B.E. (unp.)

*Boiling point:* 95°4

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 0 | 0.73795 | 15 | 377 | 15 | 21.97 | B.E. (unp.) |
| 15 | 0.72489 | 30 | 325 | 20 | 21.42 | ,, |
| 30 | 0.71211 | | | 30 | 20.40 | ,, |

*Refractive index*

| t° | He r. | He y. | He g. | He v. | |
|---|---|---|---|---|---|
| 15 | 1.41473 | 1.41777 | 1.42284 | 1.42807 | B.E. (unp.) |
| $\frac{dn}{dt}$ | 0.00048 | 49 | 49 | 49 | ,, |

*Dielectric constant:* 20° 2.052 PIETTE (unp.)

## 6-METHYLHEPTENE-1 $CH_2=CH-(CH_2)_3-CH(CH_3)-CH_3$

*Boiling point, density* and *refractive index* CLEVELAND (1943)

EYKMAN in his posthumous works, WIBAUT and GELDOF (1946), HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947) have studied the long-chain ethylenic hydrocarbons. These seem to have been carefully purified.

## C. DIENES

### BUTADIENE-1,3 $CH_2=CH-CH=CH_2$

**Constants:** Scott, Meyers, Rands Jr, Brickwedde and Bekkedahl (1945)

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 152 | 32420 | 0.245 | |

*Saturated vapour pressure:*

$$\log p = A - \frac{1}{T}[B + CX(10^{DX^3} - 1)] - E(T - 243.16)^6$$

where

A = 7.2363 for p in mm Hg
B = 1165,21
C = $1.5875 \times 10^{-4}$
D = $0.766 \times 10^{-10}$
X = $125{,}000 - T^2$
E = $2 \times 10^{-14}$ (not to be used above − 30° C)
T = t + 273.16 = temperature in Kelvin degrees

*Melting point*

| | |
|---|---|
| −108°917 | Scott, Meyers, etc. (1945) |
| −108°917 | Glasgow Jr., Krouskop, Beadle, Axilbrod and Rossini (1948) |

*Specific heat:* (M.W. 54.088)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.16 | 0.0178 | −188.16 | 0.2200 | L. −108.16 | 0.4568 | −38.16 | 0.4841 |
| −253.16 | 0.03566 | −183.16 | 0.2291 | −103.16 | 0.4570 | −33.16 | 0.4874 |
| −248.16 | 0.05596 | −178.16 | 0.2379 | − 98.16 | 0.4578 | −28.16 | 0.4912 |
| −243.16 | p.07633 | −173.16 | 0.24626 | − 93.16 | 0.4585 | −23.16 | 0.4955 |
| −238.16 | 0.09590 | −168.16 | 0.25425 | − 88.16 | 0.4594 | −18.16 | 0.4994 |
| −233.16 | 0.1138 | −163.16 | 0.26206 | − 83.16 | 0.4609 | −13.16 | 0.5037 |
| −228.16 | 0.1302 | −158.16 | 0.27041 | − 78.16 | 0.4623 | − 8.16 | 0.5082 |
| −223.16 | 0.1454 | −153.16 | 0.27932 | − 73.16 | 0.4640 | − 3.16 | 0.5132 |
| −218.16 | 0.1591 | −148.16 | 0.28855 | − 68.16 | 0.4661 | + 1.84 | 0.5187 |
| −213.16 | 0.1706 | −143.16 | 0.29835 | − 63.16 | 0.4688 | 6.84 | 0.5242 |
| −208.16 | 0.1800 | −138.16 | 0.30899 | − 58.16 | 0.4716 | 11.84 | 0.5302 |
| −203.16 | 0.1904 | −133.16 | 0.32061 | − 53.16 | 0.4740 | 16.84 | 0.5362 |
| −198.16 | 0.2006 | −128.16 | 0.33328 | − 48.16 | 0.4774 | | |
| −193.16 | 0.2104 | −123.16 | 0.34712 | − 43.16 | 0.4805 | | |

| *Heat of vaporisation* | t° | cal 15°/g | |
|---|---|---|---|
| | −26°09 | 104.22 | Scott, Meyers, etc. (1945) |
| | − 4°56 | 99.440 | „ |
| | +22°51 | 92.756 | „ |

| | | |
|---|---|---|
| *Heat of melting* | 35.283 cal 15°/g | Scott, Meyers, etc. (1945) |
| *Heat of combustion* | 25° ($c_p$) 11144.6 „ | Prosen and Rossini (1945) (M. W. 54.088) |

## PENTADIENE-1,4 $CH_2=CH-CH_2-CH=CH_2$

This product is prepared by allowing the ether of $\alpha\,\alpha'$ diallyl $\beta\,\beta'$ dibromodiethylether to react with *n*-butylalcohol and zinc.

### Constants

*Boiling point*

| | |
|---|---|
| 26°02 | Kistiakowsky, Ruhoff, Smith and Vaughan (1936) |

*Freezing point*

| | |
|---|---|
| −148°1 | Parks, Todd and Shomate (1936) |
| −148°8 | Kistiakowsky, Ruhoff, etc, (1936) |

*Specific heat:* Parks, Todd and Shomate (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −190.76 | 0.2197 | L. −147.76 | 0.4506 | −84.96 | 0.4471 | −17.56 | 0.4830 |
| −184.86 | 0.2308 | −141.56 | 0.4469 | −78.56 | 0.4498 | −12.46 | 0.4870 |
| −178.66 | 0.2424 | −135.56 | 0.4454 | −72.86 | 0.4526 | − 7.46 | 0.4913 |
| −172.16 | 0.2553 | −123.66 | 0.4438 | −58.76 | 0.4587 | − 2.14 | 0.5002 |
| −170.26 | 0.2620 | −117.66 | 0.4437 | −53.46 | 0.4609 | 11.74 | 0.5065 |
| | | −111.46 | 0.4429 | −48.16 | 0.4630 | 15.54 | 0.5091 |
| | | − 95.76 | 0.4456 | −34.76 | 0.4709 | 29.34 | 0.5114 |
| | | − 90.56 | 0.4468 | −29.56 | 0.4742 | | |

| | | |
|---|---|---|
| *Heat of melting* | 21.55 cal 15°/g | Parks, Todd and Shomate (1936) |

## 2-METHYLBUTADIENE-1,3 or ISOPRENE $CH_2=C(CH_3)-CH=CH_2$

This hydrocarbon is obtained by decomposition of dipentene vapour by means of the "isoprene lamp" after the method devised by HARRIES and GOTTLOB (1911) and modified by WHITBY and CROZIER (1932).

**Constants:** BEKKEDAHL, WOOD and WOJCIECHOWSKY (1936)

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 34°076 | BEKKEDAHL, WOOD, etc. (1936) | −145°950 | GLASGOW Jr., KROUSKOP, BEADLE, AXILBROD and ROSSINI (1948) |
| 34°3 | LECAT (passim) | −146°7 | BEKKEDAHL, WOOD, etc. (1936) |
| | | −146°8 | BEKKEDAHL and WOOD (1937) |

*Density:* 20° 0.6805

$$dt = 0.7002 - 0.9754 \cdot 10^{-3}\, t° - 0.592 \cdot 10^{-6}\, t°^2 + 0.525 \cdot 10^{-9}\, t°^3 + 9.66 \cdot 10^{-12}\, t°^4$$

*Refractive index:* $n_D^{20°}$ 1.42160 $\frac{dn}{dt}$ 0.00045

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −249.75 | 0.05574 | −173.19 | 0.2297 | −38.81 | 0.47172 |
| −244.50 | 0.07674 | L. −133.01 | 0.43157 | −29.02 | 0.47955 |
| −238.99 | 0.09560 | −127.04 | 0.43249 | −27.45 | 0.48159 |
| −233.85 | 0.1110 | −111.19 | 0.43438 | −19.70 | 0.48759 |
| −228.76 | 0.1253 | −103.55 | 0.43516 | −16.11 | 0.49097 |
| −220.59 | 0.1421 | − 94.37 | 0.43737 | −10.37 | 0.49739 |
| −213.33 | 0.1575 | − 85.14 | 0.44144 | − 4.70 | 0.50319 |
| −205.80 | 0.1721 | − 76.96 | 0.44506 | − 1.12 | 0.50719 |
| −198.86 | 0.1849 | − 72.93 | 0.44703 | + 5.39 | 0.51446 |
| −191.34 | 0.1988 | − 69.84 | 0.44864 | 8.06 | 0.51748 |
| −187.36 | 0.2035 | − 66.39 | 0.44963 | 14.45 | 0.52440 |
| −183.38 | 0.2126 | − 61.55 | 0.45409 | 17.24 | 0.52679 |
| −181.09 | 0.2157 | − 57.05 | 0.45648 | 23.49 | 0.53434 |
| −180.54 | 0.2158 | − 50.18 | 0.46297 | 25.30 | 0.53838 |
| −175.76 | 0.2259 | − 47.70 | 0.46304 | | |

| | | |
|---|---|---|
| *Heat of melting* | 16.8 cal 15°/g | BEKKEDAHL and WOOD (1937) |
| *Heat of combustion* | 25° ($c_p$) 11089.5 „ | JESSUP (1938) (M. W. 68.0498) |

## D. ACETYLENES

### ACETYLENE $C_2H_2$

Is purified by allowing the gas to bubble through a solution of concentrated potassium permanganate, drying over $P_2O_5$ and fractionating under reduced pressure at low temperature.

#### Constants

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 35.50 | 61.65 | — | Cardoso (1912) |
| 35.4 | — | 0.2315 | Mathias (1909) |

*Densities of the liquid and the saturated vapour:* Mathias (1909)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| −23.75 | 0.5185 | 0.0217 | 28.98 | 0.3559 | 0.1160 |
| + 6.11 | 0.4476 | 0.0528 | 29.07 | 0.3556 | 0.1163 |
| 12.05 | 0.4295 | 0.0632 | 31.43 | 0.3379 | 0.1305 |
| 17.07 | 0.4120 | 0.0740 | 32.09 | 0.3315 | 0.1361 |
| 20.30 | 0.3987 | 0.0831 | 32.88 | 0.3282 | 0.1393 |
| 23.42 | 0.3859 | 0.0925 | 33.74 | 0.3146 | — |
| 24.11 | 0.3814 | 0.0958 | 35.4 | 0.2315 | 0.2315 |

*Weight of the normal litre in the gaseous state:* 1.17910 Stahrfoss (1918)
*Deviation from Avogadro's law:* $A_0^1 = 1.00884$ Howarth and Burt (1924–25)

### PROPYNE or METHYLACETYLENE (ALLYLENE) $CH \equiv C-CH_3$

Prepared by the reaction of propylene bromide with alcoholic soda. Purified by repeated fractional distillation or by means of the copper salt or by way of the sodium derivative.

*Saturated vapour pressure:* Heisig and Hurd (1933)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −79.5 | 26.7 | −52.5 | 169.6 | −33.0 | 478.2 |
| −75.2 | 37.1 | −45.6 | 249.9 | −27.8 | 612.3 |
| −71.0 | 49.3 | −38.7 | 361.6 | −23.5 | 743.5 |
| −64.2 | 80.7 | | | | |

*Boiling point:* −23.1 Heisig and Hurd (1933)

## BUTYNE-2 or 1,2-DIMETHYLACETYLENE $CH_3-C\equiv C-CH_3$

Prepared from an equimolecular mixture of methyl iodide and the sodium compound of methylacetylene. The product cristallizes on cooling and is purified by washing and fractional distillation.

### Constants

*Saturated vapour pressure:* Heisig and Davis (1935)

| t° | p mm | t° | p mm |
|---|---|---|---|
| L. 0 | 252.8 | S. −38.70 | 27.9 |
| −31.2 | 49.3 | −34.55 | 38.6 |

*Boiling point:* 27°2 Heisig and Davis (1935)

*Melting point*

| | |
|---|---|
| −32°23 | Yost, Osborne and Garner (1941) |
| −32°260 | Streiff, Murphy, Zimmerman, Soule, Sedlak, Willingham and Rossini (1947) |
| −32°5 | Heisig and Davis (1935) |

*Specific heat:* Yost, Osborne and Garner (1941) (M.W. 54.089)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.46 | 0.0136 | −222.76 | 0.1547 | −160.12 | 0.3167 | −82.15 | 0.3517 |
| −256.20 | 0.01928 | −215.92 | 0.1792 | −154.92 | 0.3262 | −77.04 | 0.3564 |
| −254.08 | 0.02587 | −211.59 | 0.1936 | −149.52 | 0.3347 | −71.10 | 0.3631 |
| −252.13 | 0.03256 | −207.02 | 0.2084 | −143.92 | 0.3451 | −64.09 | 0.3707 |
| −250.11 | 0.04015 | −202.05 | 0.2231 | −143.85 | 0.3452 | −56.94 | 0.3801 |
| −247.96 | 0.04897 | −196.76 | 0.2385 | −138.96 | 0.3547 | −49.69 | 0.3927 |
| −245.75 | 0.05823 | −191.19 | 0.2525 | −133.87 | 0.3646 | −42.46 | 0.4265 |
| −243.41 | 0.06790 | −185.36 | 0.2662 | — | — | L. − 8.21 | 0.5345 |
| −241.20 | 0.07781 | −180.79 | 0.2762 | −108.86 | 0.3254 | + 1.55 | 0.5401 |
| −238.79 | 0.08856 | −175.62 | 0.2866 | −103.33 | 0.3308 | 11.17 | 0.5461 |
| −235.50 | 0.1026 | −170.67 | 0.2969 | − 97.81 | 0.3360 | | |
| −231.29 | 0.1201 | −165.50 | 0.3067 | − 92.58 | 0.3406 | | |
| −227.22 | 0.1368 | | | − 87.33 | 0.3467 | | |

(Between 130° and 110°, the heat capacity is abnormally high)

| | | |
|---|---|---|
| *Heat of vaporisation* | 17°84 119.2 cal 15°/g | Yost, Osborne and Garner (1941) |
| *Heat of melting* | 40.8 „ | „ |

### HEXYNE-1 or *n*-BUTYLACETYLENE $CH \equiv C-(CH_2)_3-CH_3$

Prepared by the action of alcoholic potash on dibromo 1.2-hexane, purified by washing with water, drying over $Na_2CO_3$ and subjecting to fractional distillation.

**Constants:** VAN RISSEGHEM (1926)

*Boiling point:* 71°38

*Freezing point:* −124°

*Density*

| t° | d |
|---|---|
| 0 | 0.7336 |
| 15 | 0.7193 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | Hγ |
|---|---|---|---|---|---|---|
| 15 | 1.3991 | 1.3994 | 1.40195 | 1.40615 | 1.4076 | 1.4125 |

In EYKMAN's posthumous papers information may be found concerning heptyne-1 $C_5H_{11}C{\equiv}CH$, undecyne-1 $C_9H_{19}C{\equiv}CH$, hexadecyne-1 $C_{14}H_{29}C{\equiv}CH$, octadecyne-1 $C_{16}H_{33}C{\equiv}CH$.

## E. AROMATIC HYDROCARBONS

### BENZENE $C_6H_6$

The purification is carried out in two stages:

(1) It is necessary first to eliminate, by chemical means, the thiophen, which gives mixed crystals with benzene; this result is attained either by shaking the benzene with a little concentrated sulphuric acid (MEYER, 1910), or by boiling it over mercuric oxide (DIMROTH, 1899) or over anhydrous aluminium chloride (HALLER, 1892). The best criterion for the absence of thiophen is the isatin reaction (MEYER, 1910; GILLO, 1938).

(2) The purification is continued by physical methods of fractionation which result in the elimination of traces of homologues and of hydrocarbons belonging to other series. The fractional distillation is followed by fractional melting until the melting point is constant or by crystallization from aqueous alcohol (SWIETOSLAWSKI).

Ewins (1914) used as a supplementary criterion of purity the critical solution point with anhydrous formic acid (81°9).

Gillo (1938-39) determined the traces of impurities contained in benzene which had been purified in this manner, and obtained benzene containing less than $10^{-3}$ % of water and less than $2 \cdot 10^{-5}$ % of thiophen: the latter was determined by chromometry (mercury salt) and colorimetry (isatin). It is easy to attain the fifth degree of purity ($\Delta t = 0.000°$) as shown by the ebulliometer of Swietoslawski.

Wojciechowski (1936) has made a very careful study of benzene at the National Bureau of Standards.

Intensive dessication of benzene by purified $P_2O_5$ produces variations in the physical constants of benzene, especially in the vapour pressure (Lacoss and Menzies (1937).

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 288°5 | 36400 | 0.3045 | Young (1910) |
| 288°5 | — | 0.3044 | Simon (1938) |
| 288°68 | 37460 | — | Schamhardt (1908) |

*Densities of the liquid and the saturated vapour:* Young (1900—10)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.90006 | 0.00012 | 170 | 0.7043 | 0.02087 |
| 10 | 0.8895 | 0.0002 | 180 | 0.6906 | 0.02487 |
| 20 | 0.8790 | 0.0004 | 190 | 0.6758 | 0.02977 |
| 30 | 0.8685 | 0.0006 | 200 | 0.6605 | 0.03546 |
| 40 | 0.8576 | 0.0008 | 210 | 0.6432 | 0.04207 |
| 50 | 0.8466 | 0.0011 | 220 | 0.6255 | 0.05015 |
| 60 | 0.8357 | 0.0015 | 230 | 0.6065 | 0.05977 |
| 70 | 0.8248 | 0.002040 | 240 | 0.5851 | 0.07138 |
| 80 | 0.8145 | 0.002732 | 250 | 0.5609 | 0.08554 |
| 90 | 0.8041 | 0.003610 | 260 | 0.5328 | 0.1038 |
| 100 | 0.7927 | 0.004704 | 270 | 0.4984 | 0.1287 |
| 110 | 0.7809 | 0.006042 | 280 | 0.4514 | 0.1660 |
| 120 | 0.7692 | 0.007675 | 284.3 | 0.4213 | — |
| 130 | 0.7568 | 0.009851 | 286.1 | 0.4078 | — |
| 140 | 0.7440 | 0.01176 | 288.0 | 0.3856 | — |
| 150 | 0.7310 | 0.01437 | 288.5 | 0.3045 | 0.3045 |
| 160 | 0.7185 | 0.01734 | | | |

*Rectilinear diameter:* $0.4501 - 5248 \cdot 10^{-7} t + 693 \cdot 10^{-10} t^2$ YOUNG (1900–10)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −35.1 | 1.381 | −48.8 | 0.361 | | | MÜNDEL (1913) |
| −43.8 | 0.606 | −52.4 | 0.247 | | | „ |
| −45.5 | 0.510 | −56.0 | 0.217 | | | „ |
| | | −58.6 | 0.124 | | | „ |
| −10 | (S) 14.97 | 110 | 1739 | 220 | 14521 | YOUNG (1910) |
| 0 | (L) 26.54 | 120 | 2230 | 230 | 16825 | „ |
| 10 | 45.19 | 130 | 2821 | 240 | 19352 | „ |
| 20 | 74.13 | 140 | 3520 | 250 | 22182 | „ |
| 30 | 117.45 | 150 | 4335 | 260 | 25329 | „ |
| 40 | 180.20 | 160 | 5300 | 270 | 28852 | „ |
| 50 | 268.30 | 170 | 6386 | 280 | 32782 | „ |
| 60 | 388.51 | 180 | 7617 | 284.30 | 34594 | „ |
| 70 | 548.16 | 190 | 9045 | 286.1 | 35436 | „ |
| 80 | 755.0 | 200 | 10650 | 288.0 | 36226 | „ |
| 90 | 1008 | 210 | 12453 | 288.5 | 36395 | „ |
| 100 | 1335 | | | | | „ |
| 0 | 26.524 | 40 | 181.108 | 90 | 1016.12 | FIOCK, GINNINGS and HOLTON (1931) |
| 10 | 45.448 | 50 | 268.964 | 100 | 1344.44 | |
| 20 | 74.632 | 60 | 388.588 | 110 | 1748 | „ |
| 25 | 93.860 | 70 | 547.428 | 120 | 2238.20 | „ |
| 30 | 118.256 | 80 | 753.616 | 130 | 2824.92 | „ |
| 8.86 | 42.6 | 24.00 | 89.7 | 54.87 | 312.4 | SCHMIDT (1934) |
| 10.20 | 45.5 | 26.01 | 98.4 | 56.95 | 347.1 | „ |
| 12.10 | 50.4 | 30.73 | 122.0 | 58.81 | 372.1 | „ |
| 13.70 | 54.8 | 33.45 | 136.9 | 63.33 | 437.0 | „ |
| 14.11 | 56.1 | 34.67 | 144.5 | 64.49 | 454.7 | „ |
| 15.20 | 58.8 | 40.25 | 183.0 | 69.57 | 540.9 | „ |
| 16.31 | 62.4 | 42.65 | 201.7 | 76.22 | 671.9 | „ |
| 18.59 | 69.7 | 46.20 | 231.2 | 80.00 | 756.2 | „ |
| 20.20 | 75.6 | 49.92 | 267.5 | 80.15 | 760.0 | „ |
| 20.54 | 76.7 | 50.00 | 268.3 | 81.30 | 789.2 | „ |
| 22.99 | 86.1 | 50.72 | 276.0 | | | „ |
| 14.548 | 57.41 | 39.078 | 175.89 | 74.028 | 627.93 | WILLINGHAM, TAYLOR, PIGNOCCO and ROSSINI (1945) |
| 17.720 | 67.22 | 44.284 | 217.16 | 78.891 | 732.07 | |
| 20.594 | 77.28 | 49.066 | 261.75 | 79.413 | 744.04 | „ |
| 23.270 | 87.75 | 54.832 | 324.93 | 79.898 | 755.23 | „ |
| 26.886 | 103.64 | 60.784 | 402.42 | 80.442 | 767.94 | „ |
| 31.004 | 124.67 | 67.135 | 500.69 | 80.922 | 779.34 | „ |
| 35.191 | 149.43 | | | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 17.72 | 67.18 | 31.62 | 127.34 | — | — | Dejardin (1919) |
| 21.54 | 80.51 | 35.11 | 148.05 | 80.0 | 756.49 | ,, |
| 24.22 | 91.43 | 38.54 | 170.95 | 80.15 | 760.00 | ,, |
| 28.85 | 112.63 | 41.20 | 190.82 | 80.35 | 764.68 | ,, |
| 23.6 | 88.5 | 40.8 | 187.4 | 51.3 | 284.0 | Jolly and Briscoe (1926) |
| 29.2 | 114.5 | 43.7 | 210.8 | 53.2 | 305.3 | ,, |
| 33.5 | 138.6 | 46.5 | 235.6 | 54.8 | 325.6 | ,, |
| 37.2 | 161.7 | 48.8 | 258.3 | | | ,, |
| 24.368 | 92.52 | 51.672 | 289.13 | 80.098 | 760.00 | Smith (1941) |
| 29.739 | 118.06 | 57.267 | 355.22 | 85.918 | 906.06 | ,, |
| 35.155 | 149.40 | 62.908 | 433.56 | 91.783 | 1074.58 | ,, |
| 40.616 | 187.57 | 68.593 | 526.86 | 97.693 | 1268.03 | ,, |
| 46.121 | 233.72 | 74.323 | 633.99 | 103.647 | 1489.14 | ,, |
| 26.3 | 100 | 60.9 | 401 | | | Schreinemakers (1904) |
| 35.4 | 150.2 | 67.3 | 500.5 | | | ,, |
| 42.5 | 202.1 | 73.0 | 601.6 | | | ,, |
| 47.8 | 249.6 | 77.7 | 700.7 | | | ,, |
| 52.9 | 301.4 | 79.2 | 731.1 | | | ,, |
| 36.73 | 155.8 | 55.09 | 326.7 | 69.67 | 544.7 | Gilmann and Gross (1938) |
| 40.90 | 188.5 | 60.63 | 389.9 | 74.98 | 646.0 | ,, |
| 45.13 | 223.9 | 64.89 | 461.2 | 79.78 | 753.0 | ,, |
| 50.19 | 272.1 | | | | | ,, |
| 59.796 | 388.58 | 99.615 | 1344.3 | — | — | Zmaczynski (1930) |
| 69.846 | 547.40 | 109.762 | 1748.2 | — | — | [see also Swietoslawski |
| 79.849 | 753.62 | — | — | — | — | ,, (1930)] |
| 89.988 | 1016.1 | — | — | — | — | ,, |
| 63.16 | 439.1 | 80.30 | 765.5 | 105.97 | 1501 | Smith and Menzies (1910) |
| 66.55 | 492.0 | 90.48 | 1031 | 111.54 | 1820 | ,, |
| 71.09 | 563.7 | 95.67 | 1197 | 119.93 | 2235 | ,, |
| 74.79 | 640.8 | 100.42 | 1364 | | | ,, |
| 230.10 | 16830 | 271.18 | 30058 | — | — | Schamhardt (1908) |
| 241.32 | 19990 | 281.42 | 34088 | — | — | ,, |
| 251.38 | 22950 | 285.70 | 34758 | — | — | ,, |
| 257.14 | 24510 | — | — | — | — | ,, |
| 25 | 94.91 | — | — | — | — | Hovorka and Dreisbach (1934) |
| 49.99 | 268.0 | — | — | — | — | Zawidsky (1900) |

Scatchard, Wood and Mochel (1939) have done very careful work, but their values are in disagreement with those of the other authors.

*Boiling point*

All modern measurements give values between 80·05 and 80·15.

| | | | |
|---|---|---|---|
| 80·07 | Maryott, Hobbs and Gross (1940) | 80·094 | Smith and Matheson (1938) and Wojciechowski (1937) |
| 80°08 | Gibbons, Thompson, Reynolds, Wright, Chanan, Lamberti, Hipsher and Karabinos (1946) | 80°106 | Zmaczynski (1930) |
| | | 80°103 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 80·093 | Wojciechowski (1936) | 80·105 | Scatchard, Wood and Mochel (1939) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°422 | Schmidt (1934) | 0°4279 | Zmaczynki (1930) |
| 0°4268 | Smith and Matheson (1938) | 0°43 | Crafts (1887) |
| 0°427 | Dejardin (1919) | 0°43 | Young (1900–10) |
| 0°4273 | Forziati, Glasgow Jr., etc.(1946) | 0°43 | Lecat (passim) |

*Freezing point*

| | | | |
|---|---|---|---|
| 5°496 | Davison (1945) | 5°530 | Streiff and Rossini (1944) |
| 5°50 | B.E. (1926) and Deffet (1935) | 5·53 | Simonsen and Washburn (1946) |
| 5°50 | Gibbons, Thompson, etc. (1946) | 5°53 | Tompa (1948) |
| 5·50 | Linton (1940) | 5·533 | Forziati, Glasgow Jr., etc.(1946) and Glasgow Jr., Murphy, Willingham and Rossini (1946) |
| 5°51 | Wojciechowski (1937) | | |
| 5·53 | Tompa (1948) | | |

*Triple point*

| | |
|---|---|
| 5°525 | Oliver, Eaton and Huffman (1948) |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 5.50 | 1 | 25.00 | 728 | Deffet (1935) |
| 10.00 | 166 | 30.00 | 917 | ,, |
| 15.00 | 349 | 32.00 | 993 | ,, |
| 20.00 | 538 | | | ,, |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.89996 | B.E. (1926) | 25 | 0.87366 | Simonsen and Washburn (1946) |
| 15 | 0.88420 | „ | | | |
| 30 | 0.86844 | „ | | | |
| | | | 25 | 0.87366 | Wojciechowski (1937) |
| 0 | 0.89990 | Massart (1936) | 25 | 0.87367 | „ |
| 14.95 | 0.88434 | „ | | | |
| 30.10 | 0.86828 | „ | 0 | 0.90006 | Young (1910) |
| 45.95 | 0.85104 | „ | 10 | 0.8895 | „ |
| | | | 15 | 0.8842 | „ |
| 0 | 0.89993 | Biron (1910) | 20 | 0.8790 | „ |
| 40 | 0.8573 | „ | 25 | 0.8737 | „ |
| | | | 30 | 0.8685 | „ |
| 16.2 | 0.8828 | Kalff (1924) | 40 | 0.8576 | „ |
| 16.35 | 0.8826 | „ | 50 | 0.8466 | „ |
| | | | 60 | 0.8357 | „ |
| 17.95 | 0.88112 | Patterson (1902) | | | |
| 25.25 | 0.87336 | „ | 20.00 | 0.87909 | Cohen and Burlj (1937) |
| 32.90 | 0.86514 | „ | 24.00 | 0.87485 | „ |
| 42.65 | 0.85462 | „ | 28.00 | 0.87058 | „ |
| 47.05 | 0.84989 | „ | 32.00 | 0.86624 | „ |
| | | | 36.00 | 0.86206 | „ |
| 20 | 0.87903 | Forziati, Glasgow Jr., | 40.00 | 0.85769 | „ |
| 25 | 0.87368 | „ etc. (1946) | 44.00 | 0.85343 | „ |
| 25 | 0.87368 | Scatchard, Wood and Mochel (1946) | 48.00 | 0.84913 | „ |
| | | | 52.00 | 0.84469 | „ |
| 30 | 0.86836 | „ | 56.00 | 0.84032 | „ |
| | | | 60.00 | 0.83602 | „ |
| 10 | 0.88946 | Tyrer (1914) | | | |
| 15.8 | 0.8835 | Meyer and Mylius (1920) | 25 | 0.87368 | Linton (1940) |
| 17 | 0.88195 | Schmidt (1926) | 25 | 0.87368 | Le Fevre and Le Fevre (1936) |
| 20 | 0.87888 | Zmaczynski (1930) | | | |
| 20 | 0.8789 | Grosse and Wackher (1939) | 25 | 0.87370 | Few and Smith (1949) |
| 20 | 0.8789 | Gibbons, etc. (1946) | 25 | 0.87376 | Campbell and Miller (1947) |
| 20 | 0.87893 | Briscoe, Peel and Robinson (1929) | | | |
| 20 | 0.8790 | Coulson, Hales and Herington (1948) | 30 | 0.86840 | de Bruyne, Davis and Gross (1933) |
| 20 | 0.8790 | Dezelic (1937) | 50 | 0.8468 | Hubbard (1910) |
| 20 | 0.8791 | Weegman (1888) | | | |
| 25 | 0.87360 | Olsen and Washburn (1935) | | | |
| 25 | 0.87363 | Barbaudy (1926) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.15 | 910 | Meyer and Mylius (1920) | 12.20 | 737 | Kolossowski (1925) |
| 15.8 | 690 | ,, | 16.32 | 692 | ,, |
| 17.2 | 680 | ,, | 17.15 | 684 | ,, |
| 28.8 | 571 | ,, | 22.50 | 624 | ,, |
| 36.0 | 530 | ,, | 28.73 | 573 | ,, |
| 46.5 | 465 | ,, | 31.30 | 550 | ,, |
| 58.3 | 402 | ,, | 35.10 | 520 | ,, |
| 67.9 | 365 | ,, | 40.02 | 482 | ,, |
| 72.7 | 350 | ,, | | | |
| 14.8 | 708.0 | Heydweiller (1896) | 15 | 696 | B.E. (1926) |
| 30.8 | 554.4 | ,, | 30 | 566 | ,, |
| 46.9 | 447.9 | ,, | 60 | 395 | ,, |
| 20 | 649 | Dezelic (1937) | 25.0 | 599 | Linebarger (1896–1897) |
| 25 | 596.1 | Lewis (1924) | 25.0 | 601 | Dunstan, Hilditch and Thole (1913) |
| 30 | 569 | Puschin and Pinter (1929) | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 0 | 31.87 | Richards, Speyers and | 13.5 | 29.72 | Sugden (1924) |
| 34.95 | 26.99 | ,, Carver (1924) | 20 | 28.88 | ,, |
| 6.7 | 30.49 | Schiff (1884) | 21.0 | 28.74 | ,, |
| 10 | 30.26 | Harkins and Cheng (1921) | 32.5 | 27.30 | ,, |
| 20 | 28.90 | ,, | 34.5 | 26.98 | ,, |
| 30 | 27.61 | ,, | 39.0 | 26.36 | ,, |
| 15 | 29.55 | Hennaut-Roland and | 41.5 | 26.08 | ,, |
| 20 | 28.88 | ,, Lek (1931) | 54.8 | 24.28 | ,, |
| 30 | 27.57 | ,, | 61.0 | 23.61 | ,, |
| 20 | 28.88 | Richards and Carver | 72.0 | 22.15 | ,, |
| | | (1921) and Richards and | 90 | 20.13 | ,, |
| | | Coombs (1915) | 120 | 16.42 | ,, |
| 20 | 28.88 | Harkins and Brown (1919) | | | |
| 20 | 28.89 | Brown (1932) | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 11.27 | 1.50123 | — | — | 1.50676 | 1.51639 | — | — | — | KALFF (1924) |
| 32.7 | 1.48742 | — | — | 1.49277 | 1.50211 | — | — | — | ,, |
| $\frac{dn}{dt}$ | 0.000635 | — | — | 0.000652 | 0.000666 | — | — | — | ,, |
| 15 | — | 1.49952 | 1.50439 | 1.50446 | — | 1.51633 | — | 1.52681 | B.E. (1926) |
| $\frac{dn}{dt}$ | — | 0.00063 | 63 | 63 | — | 64 | — | 65 | ,, |
| 16.5 | — | — | 1.5033 | — | — | — | — | — | PUSCHIN and MATAVULJ (1932) |
| 20.0 | — | — | 1.5010 | — | — | — | — | — | |
| $\frac{dn}{dt}$ | — | — | 0.0006 | — | — | — | — | — | ,, |
| 20 | — | — | 1.50110 | — | — | — | — | — | FORZIATI, GLASGOW, etc. (1946) |
| 25 | — | — | 1.49790 | — | — | — | — | — | |
| $\frac{dn}{dt}$ | — | — | 0.00064 | — | — | — | — | — | ,, |
| 15 | — | — | — | 1.50439 | — | — | — | — | ZMACZYNSKI (1930) |
| 20 | — | 1.4963 | 1.5009 | 1.5012 | 1.5110 | 1.5133 | — | — | LOWRY and ALLSOPP (1931) |
| 20 | — | 1.4960 | — | — | — | — | — | — | MICHIELEWICZ (1938) |
| 20 | — | — | 1.5009 | — | — | — | — | — | MARSCHNER and CROPPER (1946) |
| 20 | — | — | 1.5010 | — | — | — | — | — | HARRISON and BERG (1946) |
| 20 | — | — | 1.5011 | — | — | — | — | — | GIBBONS, etc. (1946) |
| 20 | — | — | 1.5011 | — | — | — | — | — | COULSON, HALES, etc. (1948) |
| 20 | — | — | 1.5011 | — | — | — | — | — | GROSSE and WACKHER (1939) |
| 20 | — | — | 1.50115 | — | — | — | — | — | DAVIES (1936) |
| 25 | — | — | 1.4979 | — | — | — | — | — | COHEN and BUIJ (1937) |
| 25 | — | — | 1.49794 | — | — | — | — | — | HUBBARD (1910) |
| 25 | — | 1.49331 | 1.49795 | — | — | 1.50985 | — | 1.52019 | BARBAUDY (1926) |
| 25 | — | 1.49331 | 1.49797 | — | — | — | — | — | CAMPBELL and MILLER (1947) |
| 25 | — | — | 1.49807 | — | — | — | — | — | WOJCIECHOWSKI (1936–37) |
| 25 | — | — | 1.49807 | — | — | — | — | — | SIMONSEN and WASHBURN (1946) |
| 25 | — | — | 1.4981 | — | — | — | — | — | FEW and SMITH (1949) |
| 25 | — | — | 1.4981 | — | — | — | — | — | TOMPA (1948) |
| 25.2 | — | — | 1.49779 | — | — | — | — | — | ZAWIDZKI (1900) |
| 30 | — | — | 1.49486 | — | — | — | — | — | DE BRUYNE, etc. (1933) |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 5.5 | 2.311 | Errera (1926) | 9.2 | 2.306 | Hadamard (1937) |
| 10 | 2.3024 | Le Fevre (1938) | 9.9 | 2.304 | ,, |
| 15 | 2.2925 | ,, | 12.3 | 2.2975 | ,, |
| 30 | 2.2628 | ,, | 14.1 | 2.294 | ,, |
| 45 | 2.2331 | ,, | 15.8 | 2.293 | ,, |
| 55 | 2.2133 | ,, | 16.7 | 2.290 | ,, |
| 65 | 2.1935 | ,, | 17.8 | 2.288 | ,, |
| 15.3 | 2.2951 | Vaughan (1939) | 20.8 | 2.282 | ,, |
| 19.0 | 2.2884 | ,, | 21.7 | 2.280 | ,, |
| 21.0 | 2.2790 | ,, | 29.3 | 2.2675 | ,, |
| 20 | 2.2825 | Davies (1936) | 30.3 | 2.266 | ,, |
| 25 | 2.2726 | ,, | 31.1 | 2.263 | ,, |
| 20 | 2.2829 | Mouradoff (unp.) | 32.5 | 2.261 | ,, |
| | | | 33.2 | 2.259 | ,, |
| 25 | 2.273 | Jenkins and Sutton(1935) | 34.5 | 2.258 | ,, |
| 25 | 2.274 | Lunt and Ran (1930) | 34.9 | 2.256 | ,, |
| 25 | 2.274 | Ball (1930) | 35.8 | 2.255 | ,, |
| 30 | 2.2627 | Maryott, Hobbs and Gross (1940) | 40.3 | 2.247 | ,, |
| | | | 18 | 2.288 | Grimm and Patrick (1923) |
| | | | 25 | 2.272 | Sugden (1933) |
| | | | 25 | 2.2725 | Le Fevre and Le Fevre (1936) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −173.16 | 0.154 | − 93.16 | 0.231 | −13.16 | 0.355 | Stull (1937) |
| −163.16 | 0.162 | − 83.16 | 0.244 | − 3.16 | 0.376 | ,, |
| −153.16 | 0.170 | − 73.16 | 0.258 | L. + 6.84 | 0.397 | ,, |
| −143.16 | 0.179 | − 63.16 | 0.271 | 16.84 | 0.406 | ,, |
| −133.16 | 0.188 | − 53.16 | 0.286 | 26.84 | 0.413 | ,, |
| −123.16 | 0.198 | − 43.16 | 0.301 | 36.84 | 0.420 | ,, |
| −113.16 | 0.209 | − 33.16 | 0.317 | 46.84 | 0.430 | ,, |
| −103.16 | 0.219 | − 23.16 | 0.335 | | | ,, |
| C. −180.56 | 0.148 | −95.06 | 0.229 | L. +7.94 | 0.403 | Huffman, Parks |
| −175.26 | 0.152 | −78.16 | 0.250 | 9.94 | 0.404 | and Daniels (1930) |
| −170.16 | 0.156 | −71.66 | 0.260 | 13.14 | 0.406 | ,, |
| −159.36 | 0.165 | −55.06 | 0.283 | 16.74 | 0.408 | ,, |
| −143.36 | 0.180 | −43.46 | 0.301 | 21.74 | 0.410 | ,, |
| −130.16 | 0.192 | −33.66 | 0.317 | 26.84 | 0.414 | ,, |
| −122.46 | 0.200 | −23.06 | 0.335 | | | ,, |
| −110.96 | 0.211 | −13.66 | 0.355 | | | ,, |

*Specific heat* (continued)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −260.19 | 0.0088 | −201.44 | 0.1294 | −47.63 | 0.29472 | Oliver, Eaton and |
| −258.91 | 0.0111 | −194.96 | 0.13597 | C. −38.97 | 0.30843 | Huffman (1948) |
| −258.39 | 0.0123 | −187.58 | 0.14288 | −38.06 | 0.31008 | (M.W. 78.108) |
| −256.64 | 0.01627 | −179.81 | 0.14922 | −30.37 | 0.32397 | ,, |
| −256.21 | 0.01730 | −171.51 | 0.15569 | −28.14 | 0.32779 | ,, |
| −253.52 | 0.02451 | −163.04 | 0.16248 | −21.13 | 0.34060 | ,, |
| −253.13 | 0.02538 | −154.97 | 0.16905 | −18.65 | 0.34528 | ,, |
| −250.12 | 0.03445 | −147.34 | 0.17569 | −11.75 | 0.35743 | ,, |
| −249.49 | 0.03635 | −139.36 | 0.18274 | −10.00 | 0.36195 | ,, |
| −246.39 | 0.04574 | −131.32 | 0.19006 | − 3.74 | 0.37704 | ,, |
| −245.69 | 0.04763 | −123.57 | 0.19764 | − 2.88 | 0.37916 | ,, |
| −242.57 | 0.05672 | −117.08 | 0.20428 | − 2.58 | 0.37941 | ,, |
| −241.39 | 0.06019 | −115.70 | 0.20558 | L. +13.74 | 0.40911 | ,, |
| −236.65 | 0.07292 | −108.26 | 0.21328 | 16.21 | 0.41082 | ,, |
| −231.48 | 0.08496 | − 99.77 | 0.22285 | 21.80 | 0.41441 | ,, |
| −226.07 | 0.09587 | − 91.60 | 0.23260 | 27.25 | 0.41807 | ,, |
| −220.48 | 0.1055 | − 83.24 | 0.24318 | 36.57 | 0.42416 | ,, |
| −219.09 | 0.1077 | − 74.26 | 0.25491 | 45.76 | 0.43069 | ,, |
| −215.07 | 0.1135 | − 65.17 | 0.26799 | 54.81 | 0.43769 | ,, |
| −213.83 | 0.1153 | − 56.43 | 0.28087 | 63.73 | 0.44422 | ,, |
| −207.64 | 0.1231 | | | | | ,, |
| L. 20.22 | 0.412 | 30.98 | 0.419 | 42.80 | 0.429 | Trehin (1921) |
| 24.04 | 0.415 | 34.83 | 0.424 | 46.77 | 0.433 | ,, |
| 27.57 | 0.418 | 38.84 | 0.426 | 50.44 | 0.437 | ,, |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 10° | 105.2 cal 15°/g | Smits and Cannegieter (1934) |
| | 25° | 103.571 ,, | Osborne and Ginnings (1947) |
| | 50° | 99.29 ,, | Flock, Ginnings and Holton (1931) |
| | 80° | 94.16 ,, | ,, |
| | 110° | 88.51 ,, | ,, |
| *Heat of melting* | | 30.45 ,, | Meyer (1910) |
| *Heat of combustion* | 25° | ($c_p$) 9992.7 ,, | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 78.108) |
| | 25° | ($c_p$) 9998.7 ,, | Prosen, Gilmont and Rossini (1945) (M. W. 78.108) |

## TOLUENE $C_6H_5—CH_3$

*Method of purification*

The impurities of crude toluene are of the same type as those of benzene, and it is practically impossible to eliminate them all by physical methods alone; small quantities of saturated hydrocarbons of the aliphatic series or of polymethylenes are practically without influence on the boiling point. In order to obtain pure toluene it is therefore necessary to transform it into a crystallisable substance such as *para*-toluene sulphonic acid or *para*-toluidine, and after purification of that derivative to regenerate the hydrocarbon. Since they had not been submitted to this treatment, practically the whole of the samples in the literature are relatively very impure, and this is especially to be noted from their very low density, as for instance the sample which Timmermans used for his measurements of densities at low temperatures.

According to Lumsden (1919), the addition to pure toluene of 1 % of a petrol fraction with a boiling point around 110°, lowers the density by 0.0013. Orton and Jones (1919) use as criterion of purity the critical solution point in acetic acid with a known percentage of water; it is stated that the elevation of the critical solution point is 1°4 for 1 % of paraffin.

The new measurements of Zmaczynski (1930) have been carried out on a toluene of very constant boiling point, but its low density shows that it is still appreciably contaminated with other hydrocarbons.

The velocity of crystallisation is in this case an extremely sensitive criterion of purity: Michel (1938) found for the velocity of crystallisation at −110°, 29.2 cm/min.

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 319°9 | — | 0.2913 | Simon (1938) |
| 320°6 | 41.60 | — | Krase and Goodman (1930) |
| 320 8 | — | — | Fischer and Reichel (1943) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 0.0 | 6.75 | 25.0 | 28.40 | 50.0 | 92.00 | Pitzer and Scott (1943) |
| 12.5 | 14.40 | 37.5 | 52.70 | | | |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 13.72 | 15.3 | 42.09 | 65.2 | 74.23 | 236.9 | Schmidt (1934) |
| 17.68 | 19.7 | 52.04 | 101.5 | 77.95 | 270.3 | „ |
| 24.85 | 28.1 | 57.87 | 127.6 | 79.82 | 289.6 | „ |
| 25.14 | 29.2 | 59.96 | 139.0 | 82.51 | 317.5 | „ |
| 28.42 | 33.7 | 63.57 | 160.1 | 85.58 | 351.1 | „ |
| 32.24 | 41.1 | 66.53 | 178.5 | 88.47 | 385.4 | „ |
| 36.35 | 50.2 | 69.32 | 198.4 | | | „ |
| 21.98 | 22.0 | 50.35 | 92.5 | 80.88 | 298.9 | Schouteden and Deveux |
| 30.09 | 34.5 | 60.62 | 141.4 | 90.95 | 418.9 | „ (1936) |
| 40.29 | 58.0 | 70.59 | 207.7 | 100.21 | 558.6 | „ |
| 35.366 | 47.68 | 61.851 | 149.43 | 104.037 | 627.93 | Willingham, Taylor, |
| 39.343 | 57.41 | 66.079 | 175.89 | 109.312 | 732.08 | Pignocco and Rossini |
| 42.810 | 67.22 | 71.738 | 217.16 | 109.879 | 744.05 | „ (1945) |
| 45.948 | 77.28 | 76.942 | 261.75 | 110.403 | 755.24 | „ |
| 48.867 | 87.75 | 83.202 | 324.93 | 110.991 | 767.95 | „ |
| 52.802 | 103.64 | 89.667 | 402.43 | 111.509 | 779.34 | „ |
| 57.293 | 124.67 | 96.559 | 500.68 | | | „ |
| 79.772 | 289.1 | 110.603 | 760.00 | 142.563 | 1741.0 | Zmaczynski (1930) |
| 85.849 | 355.1 | 116.908 | 906.1 | 149.089 | 2026.3 | „ |
| 91.971 | 433.9 | 123.254 | 1074.6 | 155.656 | 2347.4 | „ |
| 98.137 | 525.76 | 129.646 | 1268.1 | | | „ |
| 104.349 | 633.90 | 136.082 | 1489.2 | | | „ |
| 110.7 | 760.0 | 149.5 | 2128.0 | 161.0 | 2926.0 | Krase and Goodman |
| 129.5 | 1276.8 | | | | | „ (1930) |

| t° | p atm. | t° | p atm. | t° | p atm. | |
|---|---|---|---|---|---|---|
| 175.5 | 5.18 | 234.5 | 13.25 | 279.5 | 24.81 | Krase and Goodman |
| 186.5 | 6.12 | 246.0 | 16.00 | 280.0 | 25.10 | „ (1930) |
| 194.0 | 6.98 | 250.0 | 17.05 | 283.0 | 26.00 | „ |
| 203.5 | 8.26 | 253.5 | 17.46 | 301.5 | 32.40 | „ |
| 214.4 | 9.89 | 257.2 | 17.69 | 320.0 | 41.48 | „ |
| 226.0 | 11.88 | 264.0 | 21.39 | | | „ |

*Boiling point:* Most of the recent values are between 110°6 and 110°8

| | | | |
|---|---|---|---|
| 110°606 | Zmaczynski (1930) (B. E.'s sample) | 110°623 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| | | 110°75 | Lecat (passim) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°4630 | Forziati, etc. (1946) | 0°4640 | Zmaczynski (1930) |

*Freezing point*

| | | | |
|---|---|---|---|
| −94·983 | Mair, Glasgow Jr and Rossini (1941) | −95·032 | Forziati, Glasgow Jr, Willingham and Rossini (1946) |
| −94·991 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −95·1 | Timmermans, Van der Horst and Kamerlingh-Onnes (1922) |
| −95°01 | Gibbons, Thompson, Reynolds, Wright, Chanan, Lamberti, Hipsher and Karabinos (1946) | | |

**Constants of state:** *Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.88545 | B.E. (1926) | −22.9 | 0.90665 | Massart (1936) |
| 15 | 0.87160 | „ | 0 | 0.88545 | „ |
| 30 | 0.85770 | „ | 34.50 | 0.85338 | „ |
| 8.5 | 0.87757 | Perkin (1896) | 46.10 | 0.84265 | „ |
| 15.0 | 0.8716 | „ | 46.30 | 0.84250 | „ |
| 20.0 | 0.8669 | „ | 56.40 | 0.83280 | „ |
| 25.0 | 0.8625 | „ | 80.00 | 0.81017 | „ |
| 30.0 | 0.8577 | „ | 100.25 | 0.78963 | „ |
| 0 | 0.885482 | Batuecas and Casado (1938) | 126.85 | 0.76217 | „ |
| 12.6 | 0.87319 | Orton and Jones (1919) | 20 | 0.8669 | Grosse and Wacklher (1939) |
| 15 | 0.8716 | Lumsden (1919) | 20 | 0.8670 | Gibbons, etc. (1946) |
| | | | 20 | 0.86683 | Forziati, Glasgow Jr., |
| | | | 25 | 0.86220 | „ etc. (1946) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.26 | 765.5 | Thorpe and Rodger | 15 | 623 | B.E. (1926) |
| 9.88 | 668.3 | „ (1894) | 30 | 523 | „ |
| 19.47 | 590.0 | „ | 20.6 | 583.0 | Heydweiller (1896) |
| 30.25 | 518.4 | „ | 30 | 526 | Puschin and Pinter (1929) |
| 39.86 | 466.7 | „ | | | |
| 49.43 | 421.9 | „ | | | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 29.10 | Hennaut-Roland and Lek (1931) |
| 20 | 28.52 | „ |
| 30 | 27.40 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 8.5 | — | 1.49891 | 1.50349 | — | — | 1.51528 | — | 1.52523 | PERKIN (1900) |
| 15 | 1.49471 | 1.49510 | 1.49985 | 1.50006 | 1.50927 | 1.51134 | 1.51870 | 1.52139 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00058 | — | 60 | — | — | 60 | — | 62 | „ |
| 20 | — | — | 1.49682 | — | — | — | — | — | FORZIATI, etc.(1946) |
| 25 | — | — | 1.49405 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00055 | — | — | — | — | — | „ |
| 20 | — | — | 1.4966 | — | — | — | — | — | FISCHER and REICHEL (1943) |
| 20 | — | — | 1.4967 | — | — | — | — | — | GIBBONS, etc. (1946) |
| 20 | — | — | 1.49693 | — | — | — | — | — | B.E. (1949) |

*Dielectric constant:* LE FEVRE (1938)

| t° | ε | t° | ε | t° | ε |
|---|---|---|---|---|---|
| −50 | 2.5889 | +25 | 2.3661 | 80 | 2.2449 |
| −33 | 2.5336 | 45 | 2.3196 | 100 | 2.2061 |
| −15 | 2.4785 | 60 | 2.2846 | 110 | 2.1901 |
| 0 | 2.4350 | | | | |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −168.91 | 0.1686 | −120.44 | 0.1999 | −50.02 | 0.3606 | SOUTHARD and ANDREWS (1930) |
| −160.56 | 0.1727 | −112.82 | 0.2076 | −42.95 | 0.3630 | „ |
| −151.19 | 0.1798 | −105.81 | 0.2130 | −35.58 | 0.3650 | „ |
| −143.16 | 0.1817 | L. − 83.91 | 0.3519 | −28.37 | 0.3704 | „ |
| −135.72 | 0.1888 | − 55.99 | 0.3557 | | | |
| −127.93 | 0.1953 | | | | | |
| — | — | — | — | L. + 25 | 0.4059 | VOLD (1937) |

| | | |
|---|---|---|
| *Heat of vaporisation* | 25° 98.549 cal 15°/g | OSBORNE and GINNINGS (1947) |
| *Heat of combustion* | 25° ($c_p$) 10142.8 „ | PROSEN, GILMONT and ROSSINI (1945) (M. W. 92.134) |
| | 25° ($c_p$) 10134.7 „ | COOPS, MULDER, DIENSKE and SMITTENBERG (1946) (M. W. 92.134) |

## ETHYLBENZENE $C_6H_5-C_2H_5$

The physical constants of ethylbenzene are reliable only when they apply to synthetic ethylbenzene. From this term onward, the homologous hydrocarbons are prepared by WÜRTZ's method.

**Constants:** B.E. (1926)

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 344.0 | 0.2835 | SIMON (1938) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 0 | 1.125 | 8.47 | 3.460 | 17.20 | 6.017 | SCOTT and BRICKWEDDE |
| 2.57 | 2.310 | 9.33 | 3.670 | 18.98 | 6.703 | „ (1945) |
| 4.54 | 2.640 | 10.48 | 3.944 | 19.19 | 6.786 | „ |
| 6.37 | 3.015 | 14.23 | 5.005 | 21.45 | 7.772 | „ |
| 6.50 | 3.024 | 16.42 | 5.754 | 23.45 | 8.739 | „ |
| 78.93 | 121.2 | 102.93 | 284.15 | 127.30 | 596.5 | YOUNG and FORTEY (1903) |
| 79.52 | 123.95 | 105.98 | 313.65 | 130.32 | 648.6 | „ |
| 81.60 | 134.3 | 109.11 | 346.9 | 132.24 | 684.8 | „ |
| 84.74 | 150.65 | 112.13 | 381.0 | 134.36 | 724.4 | „ |
| 87.80 | 168.15 | 115.12 | 417.45 | 135.62 | 750.2 | „ |
| 90.87 | 188.05 | 118.08 | 456.8 | 137.43 | 786.8 | „ |
| 93.96 | 209.45 | 121.06 | 499.3 | 139.44 | 829.1 | „ |
| 96.86 | 231.85 | 124.25 | 546.6 | 141.29 | 871.5 | „ |
| 99.90 | 257.15 | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 136·1 | MATHEWS (1926) | 136·25 | GIBBONS, THOMPSON, REYNOLDS, WRIGHT, CHANAN, LAMBERTI, HIPSHER and KARABINOS (1946) |
| 136·15 | B.E. (1926) and LECAT (passim) | | |
| 136·18 | YOUNG and FORTEY (1903) | | |

$\frac{dt}{dp}$ *(10 mm):* 0°48 B.E. (1926) and LECAT.

*Freezing point*

| | | | |
|---|---|---|---|
| −94°950 | Streiff and Rossini (1944) | −94°991 | Guthrie Jr., Spitzer and Huffman (1944) |
| −94°950 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −95°01 | Gibbons, etc. (1946) |

*Triple point:* −95°005 Scott and Brickwedde (1945)

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −83.6 | 0.95798 | Massart (1936) | 0 | 0.88452 | B.E. (1926) |
| −45.2 | 0.92415 | „ | 15 | 0.87130 | „ |
| −22.9 | 0.90464 | „ | 30 | 0.85810 | „ |
| 0 | 0.88458 | „ | 0 | 0.88457 | Young and Fortey (1903) |
| 14.85 | 0.87152 | „ | 8.4 | 0.87697 | Perkin (1900) |
| 26.90 | 0.86085 | „ | 20 | 0.8671 | Gibbons, etc. (1946) |
| 45.50 | 0.84412 | „ | 20.0 | 0.8672 | Mathews (1926) |
| 59.95 | 0.83138 | „ | | | |
| 79.70 | 0.81373 | „ | | | |
| 97.60 | 0.79695 | „ | | | |
| 125.90 | 0.77016 | „ | | | |

| *Viscosity* | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|
| | 15 | 697 | B.E. (1926) |
| | 30 | 581 | „ |

| *Surface tension* | t° | $\gamma$ | |
|---|---|---|---|
| | 15 | 29.75 | Hennaut-Roland and Lek (1931) |
| | 20 | 29.20 | „ |
| | 30 | 28.14 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.49374 | 1.49408 | 1.49857 | 1.49868 | 1.50750 | 1.50950 | 1.51629 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 54 | 54 | 55 | 55 | 55 | „ |
| 20 | — | — | 1.4958 | — | — | — | — | Gibbons, etc. (1946) |
| 20 | — | — | 1.49593 | — | — | — | — | Mathews (1926) |

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. −259.82 | 0.009542 | L. −91.65 | 0.35463 | Guthrie Jr., Spitzer and Huffman (1944) (M. W. 106.160) |
| −253.44 | 0.02433 | −64.35 | 0.36384 | |
| −240.88 | 0.05793 | −52.02 | 0.36935 | „ |
| −231.10 | 0.08019 | −38.18 | 0.37668 | „ |
| −220.88 | 0.098718 | −28.46 | 0.38180 | „ |
| −210.76 | 0.11470 | −17.64 | 0.38852 | „ |
| −202.02 | 0.12665 | − 6.20 | 0.39578 | „ |
| −189.97 | 0.14156 | + 4.25 | 0.40304 | „ |
| −176.34 | 0.15653 | 13.73 | 0.40979 | „ |
| −163.73 | 0.16318 | 23.07 | 0.41706 | „ |
| −146.37 | 0.18707 | 32.25 | 0.42384 | „ |
| −134.18 | 0.19991 | | | „ |
| −122.69 | 0.21178 | | | „ |
| −112.54 | 0.22303 | | | „ |
| C. −258.16 | 0.0132 | L. −95.005 | 0.3541 | Scott and Brickwedde (1945) |
| −248.16 | 0.03849 | −88.16 | 0.3557 | „ (M.W. 106.16) |
| −238.16 | 0.06480 | −78.16 | 0.3588 | „ |
| −228.16 | 0.08608 | −68.16 | 0.3624 | (other values, see authors) |
| −218.16 | 0.1038 | −58.16 | 0.3667 | |
| −208.16 | 0.1186 | −48.16 | 0.3715 | „ |
| −198.16 | 0.1315 | −38.16 | 0.3767 | „ |
| −188.16 | 0.1438 | −28.16 | 0.3825 | „ |
| −178.16 | 0.1545 | −18.16 | 0.3884 | „ |
| −168.16 | 0.1648 | − 8.16 | 0.3949 | „ |
| −158.16 | 0.1751 | + 1.84 | 0.4018 | „ |
| −148.16 | 0.1854 | 11.84 | 0.4090 | „ |
| −138.16 | 0.1957 | 21.84 | 0.4164 | „ |
| −128.16 | 0.2060 | 26.84 | 0.4205 | „ |
| −118.16 | 0.2165 | | | „ |
| −108.16 | 0.2268 | | | „ |
| − 98.16 | 0.2370 | | | „ |
| − 95.005 | 0.2403 | | | „ |

| | | | | |
|---|---|---|---|---|
| *Heat of vaporisation* | 20°85 | 95.654 | cal 15°g | Scott and Brickwedde (1945) |
| | (B.P.) | 81.08 | „ | Mathews (1926) |
| *Heat of combustion* | 25° ($c_p$) | 10277.2 | „ | Prosen, Gilmont and Rossini (1945) (M. W. 106.16) |
| | 25° ($c_p$) | 10266.9 | „ | Coops, Mulder, Dienske and Smittenberg (1946) (M. W. 106.16) |

## *n*-PROPYLBENZENE $C_6H_5-n\text{-}C_3H_7$

**Constants:** B.E. (1930)

*Boiling point*

| | | | |
|---|---|---|---|
| 159°3 | $\frac{dt}{dp}$ *(10 mm)* 0°52 LECAT (passim) | 159°45 | $\frac{dt}{dp}$ *(10 mm)* 0°52 B.E. (1930) |
| 159°31 | GIBBONS, THOMPSON, REYNOLDS, WRIGHT, CHANAN, LAMBERTI, HIPSHER and KARABINOS (1946) | | |

*Freezing point*

| | |
|---|---|
| −99°57 | GIBBONS, etc. (1946) |
| −99°585 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −95.1 | 0.95737 | MASSART (1936) | 4 | 0.8753 | PERKIN (1894) |
| −83.6 | 0.94830 | „ | 5 | 0.8745 | „ |
| −45.2 | 0.91584 | „ | 8.3 | 0.8719 | „ (1900) |
| −22.9 | 0.89754 | „ | 10 | 0.8702 | „ (1896) |
| 0 | 0.87864 | „ | 15 | 0.86635 | „ (1900) |
| 15.15 | 0.86613 | „ | 0 | 0.87864 | B.E. (1930) |
| 22.85 | 0.85966 | „ | 15 | 0.86629 | „ |
| 38.30 | 0.84691 | „ | 30 | 0.85380 | „ |
| 62.75 | 0.82642 | „ | 20 | 0.8618 | GIBBONS, etc. (1946) |
| 76.10 | 0.81482 | „ | | | |
| 99.55 | 0.79423 | „ | | | |
| 130.00 | 0.76608 | „ | | | |

| *Viscosity* | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|
| | 15 | 917 | B.E. (1930) |
| | 30 | 746 | „ |

| *Surface tension* | t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| | 15 | 29.52 | B.E. (1930) | 4.5 | 20.6 | SCHIFF (1884) |
| | 20 | 29.01 | „ | | | |
| | 30 | 28.02 | „ | | | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.48937 | 1.49016 | 1.49436 | 1.50242 | 1.50478 | 1.5111 |
| $\frac{dn}{dt}$ | 0.00044 | 46 | 46 | 46 | 48 | 47 |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 10376.9 cal 15° g | Prosen, Gilmont and Rossini (1945) (M. W. 120.186) |

## *Iso*-PROPYLBENZENE $C_6H_5-CH(CH_3)_2$

**Constants**

*Saturated vapour pressure:* Willingham, Taylor, Pignocco and Rossini (1945)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 70.020 | 47.65 | 89.077 | 103.66 | 115.495 | 261.76 | 150.956 | 732.11 |
| 74.365 | 57.41 | 93.991 | 124.67 | 122.353 | 324.95 | 151.576 | 744.08 |
| 78.155 | 67.24 | 98.975 | 149.44 | 129.433 | 402.44 | 152.152 | 755.27 |
| 81.579 | 77.29 | 103.604 | 175.89 | 136.983 | 500.72 | 152.798 | 767.96 |
| 84.768 | 87.73 | 109.802 | 217.18 | 145.176 | 627.94 | 153.367 | 779.39 |

*Boiling point*

| | | |
|---|---|---|
| 152°393 | $\frac{dt}{dp}$ *(10 mm)* 0.5076 | Forziati, Glasgow Jr., Willingham and Rossini (1945) |
| 152°42 | | Gibbons, Thompson, Reynolds, Wright, Chanan, Lamberti, Hipsher and Karabinos (1946) |

*Freezing point*

| | |
|---|---|
| −96°02 | Gibbons, etc., (1946) |
| −96°028 | Glasgow Jr, Murphy, Willingham and Rossini (1946) |

| *Density* | t° | d | |
|---|---|---|---|
| | 20 | 0.8619 | Gibbons, etc. (1946) |
| | 20 | 0.86175 | Forziati, Glasgow Jr., Willingham and |
| | 25 | 0.85748 | „ Rossini (1946) |

| | | | |
|---|---|---|---|
| *Refractive index* | $n_D^{20°}$ | 1.4912 | GIBBONS, etc., (1946) |
| | $n_D^{20°}$ | 1.49125 | FORZIATI, GLASGOW Jr., etc. (1946) |
| | $n_D^{25°}$ | 1.48874 | ,, |

| | | |
|---|---|---|
| *Heat of vaporisation* | 25° 89.769 cal 15°/g | OSBORNE and GINNINGS (1947) |
| *Heat of combustion* | 25° ($c_p$) 10371.5 ,, | JOHNSON, PROSEN and ROSSINI (1945) (M. W. 120.186) |

## *n*-BUTYLBENZENE $C_6H_5-n\text{-}C_4H_9$

The values of B.E. (1926) should be replaced by the new values below (unpublished).

### Constants

*Critical constants*

| t° cr | d cr | |
|---|---|---|
| 387.8 | 0.2697 | SIMON (1938) |

*Boiling point*

| | | |
|---|---|---|
| 183°10 | $\frac{dt}{dp}$ *(10 mm)* 0°58 | B.E. (unp.) |
| 183°1 | | LECAT (passim) |

*Freezing point*

| | |
|---|---|
| −87°970 | STREIFF, MURPHY, CAHILL, FLANAGAN, SEDLAK, WILLINGHAM and ROSSINI (1947) |
| −87°994 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) |

*Density*

| t° | d | t° | d | | t° | d | |
|---|---|---|---|---|---|---|---|
| −95.1 | 0.95132 | −22.9 | 0.89440 | MASSART (1936) | 0 | 0.87609 | B.E. (unp.) |
| −83.6 | 0.94226 | 0 | 0.87608 | „ | 15 | 0.86415 | „ |
| −45.2 | 0.91210 | +15.15 | 0.86391 | „ | 30 | 0.85221 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1114 | B.E. (unp.) |
| 30 | 892 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 29.84 | B.E. (unp.) |
| 20 | 29.38 | „ |
| 30 | 28.34 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.48729 | 1.48792 | 1.49207 | 1.49985 | 1.50199 | 1.50811 | B.E. (unp.) |
| $\frac{dn}{dt}$ | 0.00042 | 42 | 42 | 43 | 43 | 44 | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 10457.3 cal 15°/g | PROSEN, JOHNSON and ROSSINI (1946) (M. W. 134.212) |

*Iso*-BUTYLBENZENE $C_6H_5—CH_2CH(CH_3)_2$

*Sec.* „ $C_6H_5—sec.\text{-}C_4H_9$

*Tert.* „ $C_6H_5—tert.\text{-}C_4H_9$

*Freezing point:* STREIFF, CAHILL, FLANAGAN, SEDLAK, WILLINGHAM and ROSSINI (1947).

*Heat of combustion:* PROSEN, JOHNSON and ROSSINI (1946).

For *sec*-BUTYLBENZENE: *density* and *refractive index:* CUYPERS (1939).

*n*-DODECYLBENZENE $C_6H_5—n\text{-}C_{12}H_{25}$

*n*-TETRADECYLBENZENE $C_6H_5—n\text{-}C_{14}H_{29}$.

*Boiling, freezing* and *critical solution points, density, viscosity* and *refractive index:* YU, WOOD and GARNER (1912) and YU, SHEN and WOOD (1940).

*n*-AMYLBENZENE $C_6H_5-n-C_5H_{11}$ (A) *n*-HEXYLBENZENE $C_6H_5-n-C_6H_{13}$ (B)

**Constants:** SIMON (1929)

| | | (A) | | | (B) | | |
|---|---|---|---|---|---|---|---|
| *Boiling point* | | 205°3 | | | 227°35 | | |
| *Freezing point* | | —78°25 | | | —66°8 | | |
| *Density* | 0° | 0.87411 | | | 0.87527 | | |
| | 15° | 0.86261 | | | 0.86394 | | |
| | 30° | 0.85100 | | | 0.85259 | | |
| *Viscosity* · $10^5$ | 15° | 1487 | | | 1833 | | |
| | 30° | 1126 | | | 1409 | | |
| *Surface tension* | 15° | 30.18 | | | 30.70 | | |
| | 20° | 29.65 | | | 30.14 | | |
| | 30° | 28.61 | | | 29.17 | | |
| *Refractive index* | | 15° | 25° | $\frac{dn}{dt} \cdot 10^5$ | 15° | 25° | $\frac{dn}{dt} \cdot 10^5$ |
| | He r. | 1.48622 | 1.48196 | 43 | 1.48696 | 1.48297 | 40 |
| | Hα | 1.48674 | 1.48240 | 43 | 1.48745 | 1.48341 | 40 |
| | D | 1.49062 | 1.48633 | 43 | 1.49132 | 1.48718 | 41 |
| | He y. | 1.49072 | 1.48643 | 43 | 1.49151 | 1.48736 | 41 |
| | He g. | 1.49820 | 1.49390 | 43 | 1.49892 | 1.49468 | 42 |
| | Hβ | 1.50006 | 1.49572 | 43 | 1.50092 | 1.49660 | 43 |
| | He v. | 1.50597 | 1.50173 | 43 | 1.50705 | 1.50271 | 43 |
| | Hγ | 1.50834 | 1.50394 | 44 | 1.50976 | 1.50547 | 43 |

## POLYSUBSTITUTED HYDROCARBONS

## THE XYLENES

The xylenes cannot easily be separated by distillation alone, owing to the proximity of their boiling points; the *para* compound is purified by crystallization and the *ortho* and *meta* compounds in the form of solid sulphonic derivatives.

### *Ortho*-XYLENE $o-C_6H_4(CH_3)_2$

**Constants. — Polyphasic equilibria**

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 358.0 | 0.2877 | SIMON (1938) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 12.5 | 3.00 | 50.0 | 25.50 | — | — | Pitzer and Scott (1943) |
| 25.0 | 6.60 | 60.0 | 40.60 | — | — | „ |
| 37.5 | 13.50 | — | — | — | — | „ |
| 63.460 | 47.66 | 91.987 | 149.44 | 137.346 | 627.93 | Willingham, Taylor, |
| 67.746 | 57.41 | 96.541 | 175.89 | 143.007 | 732.09 | Pignocco and Rossini |
| 71.481 | 67.23 | 102.632 | 217.17 | 143.614 | 744.06 | „ (1945) |
| 74.857 | 77.28 | 108.227 | 261.75 | 144.176 | 755.25 | „ |
| 77.993 | 87.75 | 114.965 | 324.94 | 144.809 | 767.95 | „ |
| 82.242 | 103.65 | 121.909 | 402.44 | 145.367 | 779.36 | „ |
| 87.081 | 124.67 | 129.318 | 500.71 | | | „ |

$$\log p\ mm = \frac{-2908.07}{T} - 5 \log T + 22.95279$$ Stuckey and Saylor (1940)

*Boiling point*

| | | | |
|---|---|---|---|
| 144°40 | Stuckey and Saylor (1940) | 144°412 | Willingham, Taylor, Pignocco and Rossini (1945) |
| 144°4 | Brown (1905) | 144°414 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 144°41 | Gibbons, Thompson, Reynolds Wright, Chanan, Lamberti, Hipsher and Karabinos (1946) | 144°466 | Wojciechowski (1939) |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°4969 | Forziati, Glasgow Jr., etc. (1946) | 0°498 | Willingham, Taylor, etc. (1945) |
| 0°497 | Wojciechowski (1939) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −25°175 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −25°225 | Forziati, Glasgow Jr., etc. (1946) |
| −25°190 | Streiff and Rossini (1944) | −25°34 | Pitzer and Scott (1943) |
| −25°22 | Gibbons, etc. (1946) | | |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| −25.0 | 1 | −10.0 | 654 | Deffet (1935) |
| −20.0 | 220 | − 5.0 | 865 | „ |
| −15.0 | 437 | 0.00 | 1080 | „ |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −22.95 | 0.91595 | MASSART (1936) | 0 | 0.89692 | B.E. (unp.) |
| 0 | 0.89692 | ,, | 15 | 0.88428 | ,, |
| 15.00 | 0.88425 | ,, | 30 | 0.87160 | ,, |
| 29.70 | 0.87180 | ,, | 0 | 0.89683 | MILLER (1932) |
| 46.40 | 0.85765 | ,, | 20 | 0.88010 | ,, |
| 60.47 | 0.84558 | ,, | 19.12 | 0.880776 | PATTERSON (1902) |
| 79.45 | 0.82945 | ,, | 22.44 | 0.877938 | ,, |
| 106.05 | 0.80573 | ,, | 28.93 | 0.872521 | ,, |
| 15.5 | 0.8837 | AUWERS (1919) | 36.34 | 0.866286 | ,, |
| 20 | 0.8798 | GIBBONS, etc. (1946) | 20 | 0.88005 | FORZIATI, GLASGOW Jr., |
| 20 | 0.8800 | BRÜHL (1894) | 25 | 0.87583 | ,, etc. (1946) |
| 24.1 | 0.8758 | GLADSTONE (1891) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 866 | B.E. (unp.) | 65.92 | 470 | THORPE and RODGER |
| 30 | 693 | ,, | 77.48 | 420 | ,, (1894) |
| | | | 78.78 | 416 | ,, |
| 0.35 | 1097 | THORPE and RODGER | 90.37 | 374 | ,, |
| 0.49 | 1093 | ,, (1894) | 90.82 | 373 | ,, |
| 13.00 | 894 | ,, | 100.71 | 343 | ,, |
| 13.88 | 881 | ,, | 101.78 | 340 | ,, |
| 26.54 | 738 | ,, | 115.65 | 303 | ,, |
| 26.88 | 735 | ,, | 116.61 | 302 | ,, |
| 39.33 | 628 | ,, | 128.15 | 276 | ,, |
| 51.15 | 549 | ,, | 128.69 | 275 | ,, |
| 51.94 | 544 | ,, | 139.89 | 254 | ,, |
| 65.4 | 473 | ,, | 141.14 | 252 | ,, |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 30.75 | B.E. (unp.) | 17.2 | 30.41 | KREMANN and MEINGAST |
| 20 | 30.10 | ,, | 20.0 | 30.17 | ,, (1914) |
| 30 | 29.08 | ,, | 26.0 | 29.65 | ,, |
| 20.0 | 30.1 | SMITH (1944) | 37.2 | 28.40 | ,, |
| | | | 47.0 | 27.52 | ,, |
| | | | 56.5 | 26.76 | ,, |
| | | | 61.7 | 26.22 | ,, |
| | | | 70.0 | 25.42 | ,, |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.50263 | 1.50328 | — | 1.50796 | 1.51708 | 1.51946 | 1.52654 | — | B.E. (unp.) |
| $\frac{dn}{dt}$ | 0.00047 | 48 | — | 49 | 50 | 52 | 52 | — | „ |
| 9.26 | — | 1.50632 | 1.51086 | — | — | — | — | 1.53221 | Miller (1932) |
| 16.54 | — | 1.50273 | 1.50721 | — | — | — | — | 1.52847 | „ |
| $\frac{dn}{dt}$ | — | 0.00049 | 50 | — | — | — | — | 51 | „ |
| 20 | — | — | 1.50524 | — | — | — | — | — | Forziati, etc. |
| 25 | — | — | 1.50282 | — | — | — | — | — | „ (1946) |
| $\frac{dn}{dt}$ | — | — | 0.000484 | — | — | — | — | — | „ |
| 20 | — | — | 1.5052 | — | — | — | — | — | Gibbons, etc. (1946) |
| 21.6 | — | 1.50021 | 1.50463 | — | — | 1.51602 | — | 1.52578 | Brühl (1894) |

**Heat constants**

| | | |
|---|---|---|
| *Heat of melting* | 30.64 cal 15°/g | Pitzer and Scott (1943) |
| | 31.4 „ | Rossini (1933) |
| *Heat of combustion* | 25° ($c_p$) 10250.2 cal 15° g | Prosen, Gilmont and Rossini (1945) (M.W. 106.16) |
| | 25° ($c_p$) 10243.0 „ | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 106.16) |

## *Meta*-XYLENE $m$-$C_6H_4(CH_3)_2$

**Constants:** B.E. (1930)

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 343.6 | 0.2822 | Simon (1938) |

*Boiling point*

| | | | |
|---|---|---|---|
| 139°091 | $\frac{dt}{dp}$ *(10 mm)* 0°491 Wojciechowski (1939) | 139°2 | Lecat (passim) |
| 139°15 | (B.E.'s sample) White and Rose (1932) | 139°30 | $\frac{dt}{dp}$ *(10 mm)* 0°49 B.E. (1930) |
| | | 139°3 | Perkin (1896–1900) |

*Freezing point*

| | | | |
|---|---|---|---|
| −47°872 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | −47°89 | White and Rose (1932) |
| −47°890 | Streiff and Rossini (1944) | −48°05 | White and Rose (1932) (B.E.'s sample) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.88113 | Massart (1936) | 0 | 0.88113 | B.E. (1930) |
| 14.90 | 0.86848 | „ | 15 | 0.86835 | „ |
| 25.15 | 0.85958 | „ | 30 | 0.85551 | „ |
| 46.00 | 0.84140 | „ | 4 | 0.8779 | Perkin (1896) |
| 61.15 | 0.82860 | „ | 5 | 0.8770 | „ |
| 100.00 | 0.79476 | „ | 8.4 | 0.87397 | „ (1900) |
| 20 | 0.86412 | White and Rose (1932) | 10 | 0.8726 | „ (1896) |
| 27 | 0.85817 | „ | 15 | 0.8683 | „ |
| 20 | 0.86416 | „ (B.E.'s sample) | 20 | 0.8640 | „ |
| 27 | 0.85821 | „ | 25 | 0.8600 | „ |

| *Viscosity* | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|
| | 15 | 650 | B.E. (1930) |
| | 30 | 547 | „ |

| *Surface tension* | t° | $\gamma$ | |
|---|---|---|---|
| | 15 | 29.15 | Hennaut-Roland and Lek (1931) |
| | 20 | 28.63 | „ |
| | 30 | 27.56 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.49454 | 1.49527 | — | 1.49989 | 1.50889 | 1.51108 | 1.51811 | — | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00047 | 48 | — | — | 48 | 49 | 49 | — | „ |
| 8.4 | — | 1.49878 | 1.50324 | — | — | 1.51469 | — | 1.52462 | Perkin (1900) |
| 25 | — | — | 1.49467 | — | — | — | — | — | White and Rose (1932) (B.E.'s sample) |

| | | |
|---|---|---|
| *Heat of melting* | 26.01 cal 15°/g | Rossini (1933) |
| *Heat of combustion* | 25° ($c_p$) 10247.9 „ | Prosen, Gilmont and Rossini (1945) (M.W. 106.16) |
| | 25° ($c_p$) 10238.7 „ | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 106.16) |

## *Para*-XYLENE $p\text{-}C_6H_4(CH_3)_2$

The best criterion of purity is the constancy of the melting point.

**Constants**: B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t cr. | d cr. | |
|---|---|---|
| 342.75 | 0.2807 | Simon (1938) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 0 | 1.35 (S.) | 25.0 | 8.90 (L.) | 50.0 | 32.60 | Pitzer and Scott |
| 12.5 | 4.05 „ | 37.5 | 17.50 | 60.0 | 51.35 | „ (1943) |
| 58.288 | 47.66 | 86.488 | 149.45 | 131.355 | 627.93 | Willingham, Taylor, |
| 62.523 | 57.43 | 90.990 | 175.92 | 136.956 | 732.10 | Pignocco and Rossini |
| 66.216 | 67.25 | 97.013 | 217.19 | 137.558 | 744.07 | „ (1946) |
| 69.549 | 77.30 | 102.546 | 261.78 | 138.114 | 755.27 | „ |
| 72.657 | 87.73 | 109.211 | 324.97 | 138.742 | 768.00 | „ |
| 76.852 | 103.67 | 116.083 | 402.45 | 139.289 | 779.36 | „ |
| 81.636 | 124.68 | 123.409 | 500.71 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 138°348 | Forziati, Glasgow Jr., Willingham and Rossini (1946) | 138°40 | B.E. (1926) |
| | | 138°40 | Miller (1932) |
| 138.348 | Willingham, Taylor, etc. (1946) | 138.4 | White and Rose (1932) |
| 138°36 | Gibbons, Thompson, Reynolds, Wright, Chanan, Lamberti, Hipsher and Karabinos (1946) | 138°43 | Neubeck (1887) |
| | | 138°44 | Wojciechowski (1939) |
| | | 138°45 | Lecat (passim) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0.491 | Wojciechowski (1939) | 0.493 | Willingham, Taylor, etc. (1943) |
| 0°4918 | Forziati, Glasgow Jr., etc. (1946) | | |

*Melting point*

| | | | |
|---|---|---|---|
| 13°20 | Swietoslawski (1943) | 13°260 | Streiff and Rossini (1944) |
| 13°2 | Huffman, Parks and Daniels (1930) | 13°263 | Forziati, Glasgow Jr., etc.(1946) |
| | | 13°28 | Gibbons, etc., (1946) |
| 13°21 | White and Rose (1932) | 13°30 | Miller (1932) |
| 13°23 | Pitzer and Scott (1943) | 13°35 | B.E. (1926) and Deffet (1935) |
| 13°239 | Glasgow Jr., Murphy, Willingham and Rossini (1946) | 13°4 | Perkin (1900) |
| | | 13°4 | Swallow and Gibson (1934) |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 13.35 | 1 | 30.00 | 495 | Deffet (1935) |
| 15.00 | 49 | 35.00 | 647 | „ |
| 20.00 | 197 | 40.00 | 803 | „ |
| 25.00 | 343 | 45.00 | 957 | „ |
| 13.4 | 1 | 49.0 | 1110 | Swallow and Gibson (1934) |
| 20.0 | 215 | 60.6 | 1470 | „ |
| 35.0 | 670 | 65.0 | 1625 | „ |
| 41.7 | 870 | 80.0 | 2130 | „ |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 14.90 | 0.86544 | Massart (1936) | 15 | 0.86535 | B.E. (1926) |
| 25.12 | 0.85652 | „ | 30 | 0.85230 | „ |
| 46.00 | 0.83851 | „ | 15 | 0.8654 | Perkin (1896) |
| 60.60 | 0.82564 | „ | 17.2 | 0.8635 | Eykman (1911) |
| 61.05 | 0.82527 | „ | 19.5 | 0.86134 | Patterson (1902) |
| 79.70 | 0.80866 | „ | 20 | 0.86094 | Miller (1932) |
| 100.00 | 0.78998 | „ | 20 | 0.8608 | Gibbons, etc., (1946) |
| | | | 20.0 | 0.8611 | Perkin (1896) |
| 20 | 0.86100 | Forziati, Glasgow, Jr., | 25.5 | 0.85613 | Patterson (1902) |
| 25 | 0.85666 | „ etc. (1946) | 33.3 | 0.84934 | „ |
| 25 | 0.8567 | Williams and Krchma (1927) | 40.65 | 0.84294 | „ |
| | | | 27 | 0.85498 | White and Rose (1932) |
| | | | 27 | 0.85509 | „ (B.E.'s sample) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 8.31 | 751.3 | 77.38 | 350.32 | THORPE and RODGER (1894–95) |
| 20.52 | 638.7 | 88.88 | 319.7 | ,, |
| 31.20 | 561.1 | 100.81 | 290.3 | ,, |
| 41.92 | 487.5 | 111.76 | 266.5 | ,, |
| 53.61 | 441.0 | 123.83 | 244.7 | ,, |
| 68.42 | 395.8 | 135.19 | 224.9 | ,, |
| 15 | 682 | 30 | 568 | B.E. (1926) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 28.91 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 28.36 | ,, |
| 30 | 27.29 | ,, |
| 20 | 28.5 | SMITH (1944) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.49348 | 1.49420 | — | 1.49873 | 1.50771 | 1.51000 | 1.51703 | 1.51985 | B.E. (1926) |
| $\frac{dn}{dt}$ | — | 0.00048 | — | — | — | 50 | — | 50 | ,, |
| 17.2 | 1.49264 | 1.49327 | — | 1.49782 | 1.50680 | 1.50903 | 1.51597 | 1.51882 | EYKMAN 1911) |
| 20 | — | — | 1.4958 | — | — | — | — | — | GIBBONS, etc. (1946) |
| 20 | — | — | 1.49580 | — | — | — | — | — | FORZIATI, GLASGOW, JR. etc. (1946) |
| 25 | — | — | 1.49319 | — | — | — | — | — | ,, |
| $\frac{dn}{dt}$ | — | — | 0.00052 | — | — | — | — | — | ,, |
| 25 | — | — | 1.49320 (B.E.'s sample) | — | — | — | — | — | WHITE and ROSE (1932) |

WHITE and ROSE (1932) found a difference of 0.0005 for the refractive index, using the sample of B.E.

*Dielectric constant:* 20° 2.273 PIETTE (unp.)

## Heat constants

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|---|
| C. | −181.36 | 0.159 | −139.16 | 0.204 | −47.86 | 0.290 | HUFFMAN, PARKS and DANIELS |
| | −177.96 | 0.163 | −120.86 | 0.221 | −28.06 | 0.308 | " (1930) |
| | −172.16 | 0.170 | − 98.46 | 0.241 | −17.76 | 0.318 | " |
| | −166.36 | 0.176 | − 88.86 | 0.250 | − 7.06 | 0.329 | " |
| | −159.36 | 0.184 | − 68.06 | 0.271 | | | |
| | −257.40 | 0.01141 | −198.76 | 0.1363 | −93.61 | 0.2469 | PITZER and SCOTT |
| | −255.74 | 0.01497 | −192.86 | 0.1445 | −83.30 | 0.2560 | " (1943) |
| | −253.84 | 0.01922 | −186.21 | 0.1539 | −73.01 | 0.2659 | " |
| | −251.36 | 0.02521 | −178.84 | 0.1627 | −62.05 | 0.2751 | " |
| | −247.18 | 0.03591 | −170.89 | 0.1719 | −48.26 | 0.2888 | " |
| | −239.58 | 0.05801 | −162.44 | 0.1807 | −36.91 | 0.3006 | " |
| | −233.43 | 0.07251 | −153.52 | 0.1908 | −32.47 | 0.3043 | " |
| | −229.30 | 0.08232 | −144.15 | 0.2003 | −25.68 | 0.3123 | " |
| | −224.54 | 0.09216 | −134.51 | 0.2097 | −18.31 | 0.3199 | " |
| | −219.48 | 0.1026 | −124.47 | 0.2189 | −12.06 | 0.3267 | " |
| | −213.60 | 0.1130 | −114.12 | 0.2283 | −10.27 | 0.3274 | " |
| | −206.39 | 0.1246 | −103.48 | 0.2379 | | | " |
| C. | 0 | 0.3934 | 100 | 0.4686 | 220 | 0.5801 | CORRUCCINI and GINNINGS (1947) |
| | 13.2 | 0.4013 | 120 | 0.4864 | 240 | 0.6029 | " |
| L. | 20 | 0.4057 | 140 | 0.5043 | 260 | 0.6285 | " |
| | 40 | 0.4198 | 160 | 0.5223 | 280 | 0.6573 | " |
| | 60 | 0.4350 | 180 | 0.5406 | 300 | 0.6893 | " |
| | 80 | 0.4513 | 200 | 0.5596 | | | " |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 95.307 cal 15°/g | PITZER and SCOTT (1943) |
| *Heat of melting* | | 38.12 " | HUFFMAN, PARKS and DANIELS (1930) |
| | | 38.55 " | PITZER and SCOTT (1943) |
| | 0° | 37.83 " | CORRUCCINI and GINNINGS (1947) |
| *Heat of combustion* | 25° ($c_p$) | 10250.2 " | PROSEN, GILMONT and ROSSINI (1945) (M.W. 106.16) |
| | 25° ($c_p$) | 10242.9 " | COOPS, MULDER, DIENSKE and SMITTENBERG (1946) (M.W. 106.16) |

## *Pseudo*-CUMENE or 1.2.4-TRIMETHYLBENZENE $C_6H_3(CH_3)_3$

### Constants

*Saturated vapour pressure:* $\log p\,(mm) = -(2432.42\,T) + 8.437$ HOPKE and SEARS (1948)

*Boiling point:* 169°18 MAIR and SCHICKTANZ (1933)

*Melting point*

| | | | |
|---|---|---|---|
| −43°913 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) | −44°09 | MAIR and SCHICKTANZ (1933) |
| | | −44°1 | ROSSINI (1933) |

*Density:* 20° 0.87623 MAIR and SCHICKTANZ (1933)

*Refractive index:* $n_D^{25°}$ 1.5025 MAIR and SCHICKTANZ (1933)

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. −179.46 | 0.158 | L. −33.66 | 0.388 | HUFFMAN, PARKS and BARMORE (1931) |
| −173.16 | 0.166 | −26.26 | 0.392 | „ |
| −158.06 | 0.185 | −12.66 | 0.400 | „ |
| −149.46 | 0.195 | + 3.84 | 0.412 | „ |
| −132.36 | 0.214 | 10.44 | 0.415 | „ |
| −110.16 | 0.240 | 24.14 | 0.422 | „ |
| − 92.46 | 0.259 | | | „ |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 95.324 cal 15°/g | OSBORNE and GINNINGS (1947) |
| *Heat of melting* | | 22.9 „ | ROSSINI (1933) |
| *Heat of combustion* | 25° ($c_p$) | 10330.5 „ | JOHNSON, PROSEN and ROSSINI (1945) (M.W. 120.186) |

## MESITYLENE or 1.3.5-TRIMETHYLBENZENE $C_6H_3(CH_3)_3$

### Constants

*Saturated vapour pressure* from −18° to −5°: $\log p\,(mm) = -(2667.51\,T) + 9.394$ HOPKE and SEARS (1948)

*Boiling point:* 164°64 MAIR and SCHICKTANZ (1933)

*Melting point*

| | | | |
|---|---|---|---|
| −44°720 | STREIFF, MURPHY, SEDLAK, WILLINGHAM and ROSSINI (1946) | $\alpha$ −44°78 | MAIR and SCHICKTANZ (1933) |
| | | $\beta$ −51°74 | „ |
| −44°738 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) | $\alpha$ −44°8 | ROSSINI (1933) |
| | | $\beta$ −51°7 | „ |

*Density:* 20° 0.86513 MAIR and SCHICKTANZ (1933)

*Refractive index:* $n_D^{25°}$ 1.4967 MAIR and SCHICKTANZ (1933)

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 94.401 cal 15°/g | OSBORNE and GINNINGS (1947) |
| *Heat of melting* | | $\alpha$ 18.90 „ | ROSSINI (1933) |
| | | $\beta$ 15.94 „ | „ |
| *Heat of combustion* | 25° ($c_p$) | 10327.2 „ | JOHNSON, PROSEN and ROSSINI (1945) (M.W. 120.186) |

## HEMIMELLITENE or 1,2,3-TRIMETHYLBENZENE $C_6H_3(CH_3)_3$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 40.8 | 2.25 | 77.6 | 31.5 | 133.3 | 243.0 | SMITH and SPILLANE (1940) |
| 45.25 | 4.0 | 86.25 | 47.5 | 141.3 | 307.5 | „ |
| 47.8 | 5.0 | 92.8 | 56.25 | 151.06 | 405.5 | „ |
| 50.3 | 6.0 | 102.10 | 80.0 | 157.24 | 481.5 | „ |
| 51.8 | 6.75 | 109.3 | 106.0 | 162.2 | 546.0 | „ |
| 56.25 | 9.2 | 113.0 | 123.0 | 165.66 | 591.5 | „ |
| 58.2 | 10.5 | 117.14 | 140.5 | 168.21 | 639.0 | „ |
| 65.7 | 16.5 | 122.3 | 166.5 | 170.46 | 676.5 | „ |
| 71.75 | 22.0 | 127.76 | 196.5 | | | „ |

From $-14°$ to $-3°$: $\log p\,(mm) = -(2219.69/T) + 7.508$ HOPKE and SEARS (1948)

*Boiling point:* 176°10 MAIR and SCHICKTANZ (1933)

*Melting point*

| | | | |
|---|---|---|---|
| −25°41 | SMITH and SPILLANE (1940) | −25°494 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) |
| −25°47 | MAIR and SCHICKTANZ (1933) | | |

*Density* *Refractive index*

| t° | d | t° | $n_D$ | $\frac{dn}{dt}$ | |
|---|---|---|---|---|---|
| 0 | 0.9101 | 5 | 1.5209 | 0.00048 | SMITH and SPILLANE (1940) |
| 20 | 0.8944 | 10 | 1.5185 | 0.00050 | „ |
| 25 | 0.8906 | 15 | 1.5160 | 0.0006 | „ |
| 30 | 0.8866 | 20 | 1.5130 | 0.0004 | „ |
| | | 25 | 1.5110 | 0.0004 | „ |
| | | 30 | 1.5090 | | „ |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25 | 97.557 cal 15° g | Osborne and Ginnings (1947) |
| *Heat of melting* | | 16.65 „ | Rossini (1933) |
| *Heat of combustion* | 25° ($c_p$) | 10336.9 „ | Johnson, Prosen and Rossini (1945) (M.W. 120.186) |

DURENE or 1,2,4,5-TETRAMETHYLBENZENE and
*Iso*-DURENE or 1,2,3,5-TETRAMETHYLBENZENE $C_6H_2(CH_3)_4$

*Boiling point* and *saturated vapour pressure* McDougall and Smith (1930)

*Melting point* Smith and McDougall (1929)

*Melting point* and *specific heat* Huffman, Parks and Barmore (1931)

*Melting point* and *refractive index* Smith and Cass (1932)

PREHNITENE or 1,2,3,4-TETRAMETHYLBENZENE $C_6H_2(CH_3)_4$

*Boiling point* McDougall and Smith (1930)

*Boiling* and *melting points*, *density* and *refractive index* Mair and Streiff (1941)

*Specific heat* Huffman, Parks and Barmore (1931)

## PENTAMETHYLBENZENE $C_6H(CH_3)_5$

### Constants

*Melting point*

| | |
|---|---|
| 54°3 | Ferry and Thomas (1933) |
| 54°3 | Parks, West, Naylor, Fujii and Mc Claine (1946) |

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|---|
| L. | 60 | 0.457 | 90 | 0.478 | 110 | 0.494 | Ferry and Thomas (1933) |
| | 70 | 0.464 | 100 | 0.485 | 120 | 0.504 | „ |
| | 80 | 0.471 | | | | | „ |

| | | | |
|---|---|---|---|
| *Heat of combustion* | 25° ($c_p$) | 10447.2 cal 15° g | Parks, West, etc. (1946) (M. W. 148.238) |

## HEXAMETHYLBENZENE $C_6(CH_3)_6$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 165°5<br>165°5 | Van de Vloed (1938)<br>Parks, West, Naylor, Fujii and Mc Claine (1946) | 165°6 | Spaght, Thomas and Parks (1932) |

*Transition point:* 110°6 Spaght, Thomas and Parks (1932)

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| C. 30 | 0.380 | 120 | 0.466 | Spaght, Thomas and Parks (1932) |
| 40 | 0.393 | 130 | 0.480 | ,, |
| 50 | 0.407 | 140 | 0.493 | ,, |
| 60 | 0.420 | 150 | 0.507 | ,, |
| 70 | 0.434 | L. 170 | 0.555 | ,, |
| 80 | 0.448 | 180 | 0.566 | ,, |
| 90 | 0.463 | 190 | 0.576 | ,, |
| 100 | 0.478 | 200 | 0.587 | ,, |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 10503.2 cal 15°/g | Parks, West, etc. (1946) (M. W. 162.264) |

## DI-*iso*-PROPYLBENZENES *ortho*, *meta* and *para* $C_6H_4(C_3H_7)_2$-*iso*

*Saturated vapour pressure, boiling point, density* and *refractive index* Melpolder, Woodbridge and Headington (1948)

Prosen, Johnson and Rossini (1946) give the heat of combustion of a series of alkylbenzenes. Smith and Guss (1940) have studied the tetraethylbenzenes.

Gibbons, Thompson, Reynolds, Wright, Chanan, Lamberti, Hipsher and Karabinos (1946) have studied a series of diethylbenzenes; Fenske, Braun, Wiegand, Quiggle, Mc Cormick and Rank (1947), the 1 methyl, 2 and 3 *iso*propylbenzenes and the 1,3 dimethyl, 4 and 5 ethylbenzenes; Serijan, Hipsher and Gibbons (1949), the *o-m-p. tert.* butyltoluenes.

## F. POLYCYCLIC AROMATIC HYDROCARBONS

Almost all these hydrocarbons are solid at room temperature. The data of the literature concerning the density and the refractive index, in the melted state are often mutually incompatible.

### BIPHENYL $(C_6H_5)_2$

**Constants**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 528° | 31400 | 0.343 | Cork (1930) |

*Boiling point:* 256°1 Lecat (passim)

*Melting point*

| | | | |
|---|---|---|---|
| 70°2 | Eykman (1889) | 70°5 | Schiff (1884) |
| 70°4 | Cork (1930) | 70°5 | Lautsch (1928) |
| 70°5 | Efremow (1918) | | |

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| L. 77.6 | 0.408 | 136.55 | 0.457 | 164.7 | 0.499 | Newton, Kauwra and |
| 88.4 | 0.418 | 150.0 | 0.468 | 165.5 | 0.513 | De Vries (1931) |
| 126.2 | 0.446 | 157.8 | 0.478 | | | ,, |

### DIPHENYLMETHANE $C_6H_5-CH_2-C_6H_5$

**Constants**

*Saturated vapour pressure:* Crafts (1915)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 217.54 | 242.49 | 261.82 | 722.03 | 267.04 | 797.33 |
| 231.82 | 360.75 | 262.83 | 726.29 | 271.70 | 888.80 |
| 260.15 | 696.53 | 265.09 | 766.86 | 282.24 | 1104.79 |

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 264°7 | Perkin (1896) | 26°3 | Eykman (1889) |
| 264°72 | Crafts (1915) | 26°4 | Anderlini (1895) |
| 265°4 | Lecat (passim) | 26°5 | Schmidlin (1903) |
| | | 26°6 | Efremow (1918) |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 9841.5 cal 15°/g | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 168.226) |

## TRIPHENYLMETHANE $(C_6H_5)_3CH$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 93° | Schmidlin (1903) | 93°1 | Smith and Andrews (1931) |
| 93° | Anderlini (1895) | 93°2 | Morris and Cook (1935) |

*Specific heat:* Smith and Andrews (1931)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −171.26 | 0.111 | −88.76 | 0.178 | −27.16 | 0.234 | 25.34 | 0.287 |
| −147.06 | 0.131 | −72.06 | 0.193 | −13.36 | 0.247 | 37.54 | 0.304 |
| −125.76 | 0.147 | −56.36 | 0.207 | − 0.06 | 0.261 | 61.24 | 0.329 |
| −106.46 | 0.163 | −41.46 | 0.221 | +12.84 | 0.274 | 72.54 | 0.339 |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 9714.8 cal 15°/g | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 244.318) |
| | 25° ($c_p$) 9709.6 „ | Parks, West, Naylor, Fujii and Mc Claine (1946) (M.W. 244.318) |

## TETRAPHENYLMETHANE $(C_6H_5)_4C$

### Constants

*Melting point:* 283° Smith and Andrews (1931)

*Specific heat* „

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −171.26 | 0.106 | −88.76 | 0.171 | −27.16 | 0.223 | 25.34 | 0.272 |
| −147.06 | 0.123 | −72.06 | 0.185 | −13.36 | 0.235 | 37.54 | 0.288 |
| −125.76 | 0.140 | −56.36 | 0.197 | − 0.06 | 0.249 | 61.24 | 0.313 |
| −106.46 | 0.155 | −41.46 | 0.211 | +12.84 | 0.262 | 72.54 | 0.324 |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 9651.1 cal 15°/g | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 320.41) |

## 1.2-DIPHENYLETHANE or BIBENZYL $C_6H_5-CH_2-CH_2-C_6H_5$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 51°8 | Bogojawlensky and Winogradow (1908) | 51°8<br>52°00 | Efremow (1918)<br>Deffet (1940) |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 52.00 | 1 | 70.00 | 624 | Deffet (1940) |
| 55.00 | 102 | 75.00 | 801 | „ |
| 60.00 | 278 | 80.00 | 970 | „ |
| 65.00 | 448 | | | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 9909.9 cal 15° g | Coops, Mulder, Dienske and Smittenberg (1946) (M.W. 182.252) |
| | 25° ($c_p$) 9906.5 „ | Parks, West, Naylor, Fujii and Mc Claine (1946) (M.W. 182.252) |

OTHER PHENYLETHANES $(C_6H_5)_2CH-CH_3$; $(C_6H_5)_3C-CH_3$; $(C_6H_5)_2CH-CH_2(C_6H_5)$; $(C_6H_5)_3C-CH_2(C_6H_5)$; $(C_6H_5)_2CH-CH(C_6H_5)_2$; $(C_6H_5)_3C-CH(C_6H_5)_2$
*Melting point* and *specific heat* Smith and Andrews (1931)
*Heat of combustion* Coops, Mulder, Dienske and Smittenberg (1946).

## 1.2-DIPHENYLETHYLENE or STILBENE $C_6H_5-CH=CH-C_6H_5$ *(trans)*

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 124°2 | Parks and Huffman (1930) | 124°4 | Ferry and Thomas (1933) |

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −180.86 | 0.116 | −124.86 | 0.159 | −18.76 | 0.262 | Parks and Huffman |
| −179.26 | 0.118 | −108.26 | 0.174 | − 8.26 | 0.273 | „ (1930) |
| −171.46 | 0.123 | − 93.56 | 0.188 | + 3.24 | 0.284 | „ |
| −163.36 | 0.129 | − 74.36 | 0.206 | 19.64 | 0.301 | „ |
| −148.86 | 0.140 | − 61.46 | 0.219 | | | „ |
| −139.16 | 0.148 | − 45.56 | 0.235 | | | „ |

*Specific heat* (continued)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| 40 | 0.317 | 70 | 0.349 | 100 | 0.381 | FERRY and THOMAS |
| 50 | 0.328 | 80 | 0.360 | 110 | 0.391 | „ (1933) |
| 60 | 0.338 | 90 | 0.370 | 130 | 0.466 | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_v$) 9748.2 cal 15°/g<br>25° ($c_p$) 9758.1 „ | RICHARDSON and PARKS (1939)<br>„ (M.W. 180.24) |

## OTHER PHENYLETHYLENES AND DIPHENYLACETYLENE

$(C_6H_5)_2C{=}CH(C_6H_5)$; $(C_6H_5)_2C{=}C(C_6H_5)_2$; $(C_6H_5)C{\equiv}C(C_6H_5)$

*Melting point* and *specific heat:* SMITH and ANDREWS (1931)

## G. CONDENSED POLYCYCLIC AROMATIC HYDROCARBONS

### NAPHTHALENE $C_{10}H_8$

Purified by distillation and fractional crystallization from acetone. BURRIEL (1930)
Note on the stability of naphthalene. CRAFTS (1913)

**Constants. — Polyphasic equilibria**

*Critical density:* 0.314 SCHRÖER (1941)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. 10.00 | 0.0174 | 20.00 | 0.0648 | 30.00 | 0.177 | SWAN and MACK (1925) |
| C. 30 | 0.12 | 50 | 0.82 | 60 | 1.86 | WINSTROM and KULP |
| 40 | 0.33 | | | | | „ (1949) |
| L. 98.3 | 18.0 | 125.8 | 53.6 | 148.1 | 116.0 | STELZNER (1901) |
| 105.0 | 23.9 | 133.4 | 70.0 | 159.1 | 168.5 | „ |
| 112.8 | 32.5 | 141.0 | 90.4 | 165.1 | 207.1 | „ |
| 214.361 | 699.26 | 217.883 | 758.81 | 219.819 | 792.79 | FINCK and WILHELM |
| 214.487 | 702.38 | 217.873 | 758.92 | 219.920 | 794.47 | „ (1925) |
| 214.573 | 703.68 | 217.904 | 759.69 | 220.052 | 796.97 | „ |
| 214.918 | 709.54 | 217.930 | 760.21 | 220.201 | 799.44 | „ |
| 217.785 | 757.32 | 217.966 | 792.79 | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 87.47 | 11.9 | 144.45 | 103.5 | 198.53 | 482.1 | Nelson and Senseman |
| 95.00 | 15.5 | 158.95 | 165.1 | 200.50 | 505.7 | „ (1922) |
| 100.00 | 18.5 | 163.13 | 187.1 | 205.78 | 576.2 | „ |
| 104.39 | 22.9 | 175.10 | 260.8 | 206.00 | 581.9 | „ |
| 109.65 | 28.7 | 178.44 | 290.0 | 212.17 | 667.8 | „ |
| 114.70 | 35.9 | 181.20 | 310.6 | 213.30 | 682.7 | „ |
| 117.15 | 38.3 | 185.33 | 347.6 | 217.34 | 755.8 | „ |
| 128.06 | 58.7 | 188.30 | 376.5 | 217.87 | 759.2 | „ |
| 133.72 | 71.2 | 196.96 | 464.1 | 221.45 | 825.2 | „ |

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|---|---|
| 327.5 | 7.5 | 423 | 23.70 | 463.5 | 35.40 | Schröer (1941) |
| 349 | 10.10 | 426 | 24.50 | 467 | 36.90 | „ |
| 361 | 11.90 | 431.5 | 25.50 | 472 | 38.65 | „ |
| 375 | 15.20 | 438 | 27.30 | 476 | 40.40 | „ |
| 389 | 16.30 | 448 | 30.50 | 477.5 | 41.15 | „ |
| 400.5 | 18.75 | 454.5 | 32.30 | 478.5 | 41.25 | „ |
| 414.5 | 21.45 | 459.5 | 34.00 | | | „ |

$19° \rightarrow 35°$: $\log p\ mm = -[108.30/(t° + 27)] + 1.115$. Sears and Hopke (1949)

*Boiling point*

| | | | |
|---|---|---|---|
| 217°9 | Blacet, Leighton and Bartlett (1931) | 217°96 | Waidner, Mueller and Foote (1920) (corr. 217°98 Waidner and Burgess (1911)) |
| 217°94 | Callendar and Griffiths (1891) | | |
| 217°95 | Nelson and Senseman (1922) | 217°96 | Holborn and Henning (1911) |
| 217°95 | Finck and Wilhelm (1925) | 217°96 | Mair and Streiff (1940) |
| | | 218°0 | Lecat (passim) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°58 | Finck and Wilhelm (1925) | 0°58 | Waidner, Mueller and Foote (1920) |

*Melting point:*

| | | | |
|---|---|---|---|
| 80°10 | Francis and Collins (1936) | 80°25 | Lee Ward (1934) |
| 80°12 | Sunier (1931) | 80°25 | Briscoe and Rinchart (1942) |
| 80°21 | De Beule (1931) | 80°27 | Mair and Streiff (1910) |
| 80°2 | Winstrom and Kulp (1949) | | |

## Constants of state

*Density* (from 80° to 476°5): Jouravlev (1937)

| t° | d | |
|---|---|---|
| L. 85° | 0.9752 | Mair and Streiff (1940) |
| C. 30 | 1.01813 | Cohen, de Meester and Moesveld (1924) |

*Density* and *surface tension* (L.): Campbell and Campbell (1941)
*Viscosity* from 89° to 176°0: Golik and Ravikovitch (1949)
*Refractive index:* $n_D^{85°}$ 1.5898 Mair and Streiff (1940)

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| −258.02 | 0.01102 | −183.30 | 0.1049 | −80.47 | 0.1925 | Southard and Brickwedde (1933) |
| −255.43 | 0.01589 | −180.10 | 0.1071 | −75.54 | 0.1965 | |
| −251.71 | 0.02314 | −177.77 | 0.1082 | −70.31 | 0.2018 | ,, |
| −250.91 | 0.02564 | −172.39 | 0.1129 | −65.16 | 0.2071 | ,, |
| −247.62 | 0.03169 | −167.12 | 0.1160 | −60.06 | 0.2123 | ,, |
| −246.50 | 0.03387 | −161.98 | 0.1201 | −55.03 | 0.2175 | ,, |
| −243.37 | 0.03962 | −156.95 | 0.1238 | −50.06 | 0.2227 | ,, |
| −241.42 | 0.04300 | −152.05 | 0.1277 | −46.26 | 0.2271 | ,, |
| −238.81 | 0.04738 | −147.22 | 0.1322 | −45.15 | 0.2284 | ,, |
| −236.69 | 0.05086 | −142.48 | 0.1361 | −40.21 | 0.2330 | ,, |
| −233.82 | 0.05496 | −137.81 | 0.1400 | −35.38 | 0.2377 | ,, |
| −231.86 | 0.05774 | −132.83 | 0.1441 | −34.22 | 0.2394 | ,, |
| −228.52 | 0.06181 | −127.55 | 0.1487 | −30.62 | 0.2443 | ,, |
| −226.63 | 0.06420 | −122.36 | 0.1536 | −28.33 | 0.2465 | ,, |
| −222.93 | 0.06817 | −121.17 | 0.1544 | −22.48 | 0.2529 | ,, |
| −221.21 | 0.07083 | −117.23 | 0.1577 | −16.74 | 0.2595 | ,, |
| −215.79 | 0.07713 | −112.14 | 0.1623 | −11.07 | 0.2663 | ,, |
| −210.84 | 0.08215 | −109.68 | 0.1642 | − 5.46 | 0.2731 | ,, |
| −210.64 | 0.08230 | −107.16 | 0.1666 | + 0.05 | 0.2800 | ,, |
| −205.30 | 0.08668 | −104.64 | 0.1682 | 5.53 | 0.2870 | ,, |
| −199.80 | 0.09128 | − 99.67 | 0.1730 | 10.93 | 0.2940 | ,, |
| −194.58 | 0.09573 | − 94.77 | 0.1776 | 16.26 | 0.3009 | ,, |
| −189.59 | 0.1009 | − 89.93 | 0.1824 | 21.52 | 0.3088 | ,, |
| −184.78 | 0.1038 | − 85.17 | 0.1869 | | | ,, |
| −198.16 | 0.0937 | | | | | Anderson and Stegeman (1941) |
| − 38.16 | 0.2350 | | | | | ,, |
| + 16.84 | 0.2998 | (diag. see author) | | | | ,, |

| | | | |
|---|---|---|---|
| *Heat of melting* | 50° | 34.47 cal 15°/g | Lee Ward (1934) |
| | 70° | 34.94 ,, | ,, |
| | 80° | 35.06 ,, | ,, |
| *Heat of combustion* | 20°($c_v$) | 9603 cal 15°/g | Keffler (1931) |

## METHYLNAPHTHALENES $C_{10}H_7CH_3$

### Constants

| | 1-METHYL | 2-METHYL | |
|---|---|---|---|
| *Boiling point* | 244°78 | 241°14 | MAIR and STREIFF (1940) |
| *Melting point* | — | −34°1 | HUFFMAN, PARKS and BARMORE (1931) |
| | −30°77 | −34°44 | MAIR and STREIFF (1940) |
| *Density* | 25° 1.0163 | 40° 0.99045 | „ |
| *Refractive index* | 25° | 40° | |
| Hα | 1.60677 | 1.59407 | „ |
| D | 1.61494 | 1.60192 | „ |
| Hβ | 1.63672 | 1.62306 | „ |

2-METHYLNAPHTHALENE — **Heat constants.**

*Specific heat:* HUFFMAN, PARKS and BARMORE (1931)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −179.36 | 0.121 | −116.06 | 0.175 | −19.86 | 0.268 |
| −166.06 | 0.133 | − 76.56 | 0.210 | − 0.76 | 0.299 |
| −137.66 | 0.157 | − 47.96 | 0.238 | L. +37.24 | 0.383 |

| | | |
|---|---|---|
| *Heat of melting* | 20.11 cal 15° g | HUFFMAN, PARKS and BARMORE (1931) |
| *Heat of combustion* | 25° ($c_p$) 9732.82 „ | RICHARDSON and PARKS (1939) |

1 and 2 ETHYLNAPHTHALENES $C_{10}H_7.C_2H_5$

1 and 2 *Iso*-PROPYLNAPHTHALENES $C_{10}H_7.CH(CH_3)_2$

*Saturated vapour pressure, boiling point, density* and *refractive index:* KUTZ, NICKELS, MC GOVERN and CORSON (1948)

## ANTHRACENE $C_{14}H_{10}$

BURRIEL's sample was 99.9 % pure, after seven washings and two sublimations; it was further purified by recrystallization from $C_6H_6$.

Note on purification: DERNER and KING (1941)

**Constants**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 162.5 | 6.1 | 192.1 | 18.2 | 231.0 | 59.9 | STELZNER (1901) |
| 169.3 | 8.1 | 205.3 | 28.2 | 245.3 | 88.5 | „ |
| 175.8 | 10.1 | 216.3 | 39.4 | 256.2 | 116.6 | „ |
| 181.2 | 12.4 | 221.3 | 45.0 | 265.3 | 145.7 | „ |
| 186.7 | 15.0 | 225.1 | 50.1 | | | „ |
| 220 | 42.6 | 255 | 113.5 | 285 | 237.2 | NELSON and SENSEMAN |
| 225 | 49.5 | 260 | 129.1 | 290 | 265.9 | „ (1922) |
| 230 | 57.3 | 265 | 146.5 | 295 | 297.5 | „ |
| 235 | 66.1 | 270 | 165.8 | 300 | 332.0 | „ |
| 240 | 76.0 | 275 | 187.3 | 305 | 369.5 | „ |
| 245 | 87.1 | 280 | 211.0 | 310 | 410.5 | „ |
| 250 | 99.6 | | | | | „ |

$105° \rightarrow 125°$: $\log p\ mm = -\frac{5102.0}{T} + 12.002$. SEARS and HOPKE (1949)

*Boiling point*

| | | | |
|---|---|---|---|
| 339°77 | BURGSTALLER (1912) | 339°9 | BURRIEL (1930) |

*Melting point*

| | | | |
|---|---|---|---|
| 216°18 | BURRIEL (1930) | 217° | DERNER and KING (1941) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|
| 222.3 | 691 | 251.0 | 519 | 285.0 | 449 | GOLIK and RAVIKOVITCH |
| 231.25 | 614 | 260.0 | 486 | 300.1 | 429 | „ (1949) |
| 240.9 | 547 | 279.0 | 468 | | | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_v$) 9451.0 cal 15°/g | RICHARDSON and PARKS (1939) (M.W. 178.22) |
| | 25° ($c_p$) 9453.20 „ | „ |
| | 25° ($c_p$) 9448.1 „ | PARKS, WEST, NAYLOR, FUJII and MC CLAINE (1946) (M.W. 178.220) |

## PHENANTHRENE $C_{14}H_{10}$

Estimation of anthracene in phenanthrene: HIRSHBERG and BERGMANN (1939)

**Constants**

*Saturated vapour pressure:* NELSON and SENSEMAN (1922)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 230 | 58.3 | 270 | 173.6 | 310 | 424.0 |
| 235 | 68.1 | 275 | 195.7 | 315 | 469.5 |
| 240 | 79.0 | 280 | 220.0 | 320 | 518.8 |
| 245 | 91.1 | 285 | 246.7 | 325 | 572.0 |
| 250 | 104.4 | 290 | 276.1 | 330 | 629.4 |
| 255 | 119.2 | 295 | 308.3 | 335 | 691.1 |
| 260 | 135.5 | 300 | 343.7 | 340 | 757.0 |
| 265 | 153.7 | 305 | 382.1 | | |

*Melting point*

| | | | |
|---|---|---|---|
| 100°35 | NARBUTT (1905) | 100°5 | BHATNAGAR and SINGH (1928) |
| 100°5 | SCHIFF (1884) | | |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_v$) 9396.0 cal 15°/g | RICHARDSON and PARKS (1939) (M.W. 178.22) |
| | 25° ($c_p$) 9398.21 „ | „ |

## PYRENE $C_{15}H_{10}$

**Constants:** JACOBS and PARKS (1934)

*Melting point:* 150°4

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −178.96 | 0.0841 | −152.96 | 0.1079 | −68.66 | 0.178 | (maximum at −157°16) |
| −176.76 | 0.0855 | −146.96 | 0.1067 | −62.46 | 0.184 | |
| −171.06 | 0.0900 | −144.26 | 0.1097 | −32.06 | 0.214 | |
| −168.46 | 0.0924 | −137.26 | 0.1160 | −26.76 | 0.219 | |
| −162.46 | 0.1014 | −126.56 | 0.1254 | + 2.84 | 0.251 | |
| −160.96 | 0.1060 | −118.26 | 0.1322 | 8.04 | 0.257 | |
| −155.86 | 0.1135 | −105.36 | 0.1432 | 13.84 | 0.264 | |
| −154.76 | 0.1113 | − 83.16 | 0.1641 | 18.04 | 0.269 | |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_v$) 9260.1 cal 15°/g | RICHARDSON and PARKS (1939) (M.W. 202.24) |
| | 25° ($c_p$) 9261.12 „ | „ |

# H. POLYMETHYLENES

## *Cyclo*-PROPANE $C_3H_6$

**Constants:** RUEHRWEIN and POWELL (1946)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −90.029 | 26.26 | −63.234 | 164.91 | −43.283 | 473.90 |
| −82.810 | 48.95 | −58.114 | 220.85 | −37.983 | 606.18 |
| −77.465 | 66.73 | −53.107 | 289.59 | −34.809 | 698.39 |
| −73.304 | 88.24 | −48.029 | 375.88 | −32.083 | 785.59 |
| −68.117 | 122.02 | | | | |

*Boiling point:* −32°86 *Melting point:* −127°62
−127°42 KNOWLTON and ROSSINI (1949)

*Specific heat:* (M.W 42.078)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −258.71 | 0.0150 | −205.98 | 0.2232 | L. − 98.99 | 0.4271 |
| −256.30 | 0.0207 | −200.62 | 0.2365 | − 90.90 | 0.4282 |
| −253.36 | 0.03106 | −195.74 | 0.2464 | − 84.72 | 0.4301 |
| −250.38 | 0.04416 | −190.84 | 0.2576 | − 77.61 | 0.4318 |
| −247.07 | 0.05932 | −185.67 | 0.2676 | − 70.36 | 0.4351 |
| −243.34 | 0.07712 | −180.59 | 0.2780 | − 63.16 | 0.4385 |
| −239.20 | 0.09962 | −175.61 | 0.2885 | − 55.99 | 0.4423 |
| −235.56 | 0.1183 | −169.72 | 0.2963 | − 48.89 | 0.4470 |
| −232.04 | 0.1329 | −164.13 | 0.3063 | − 42.30 | 0.4527 |
| −225.32 | 0.1603 | −158.77 | 0.3137 | − 36.12 | 0.4599 |
| −221.10 | 0.1769 | −153.16 | 0.3232 | − 30.33 | 0.4608 |
| −216.19 | 0.1944 | −147.27 | 0.3348 | | |
| −211.16 | 0.2106 | −141.34 | 0.3455 | | |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | (B.P.) | 113.907 cal 15°/g | KNOWLTON and ROSSINI (1949) |
| *Heat of melting* | | 30.92 „ | |
| *Heat of combustion* | (V.) 25°($c_p$) | 11166 „ | |

## ETHYL-*cyclo*-BUTANE $C_4H_7-C_2H_5$

*Boiling, melting* and *critical solution points, density, surface tension* and *refractive index* WIBAUT, HOOG, LANGEDYK, OVERHOFF and SMITTENBERG (1938)
*Melting point* STREIFF, ZIMMERMAN, SOULE, BUTT, SEDLAK, WILLINGHAM and ROSSINI (1948)

## *Cyclo*-PENTANE $C_5H_{10}$

Prepared by catalytic hydrogenation of *cyclo*pentene obtained by dehydration of synthetic *cyclo*pentanol.

**Constants:** B.E. (1937). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 238.60 | 44.550 | 0.270 | Kay (1947) |

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 15.707 | 217.19 | Willingham, Taylor, | −47.25 | 6.23 | Aston, Fink and |
| 20.196 | 261.71 | Pignocco and Rossini | −38.36 | 11.78 | Schumann (1943) |
| 25.598 | 324.94 | „ (1945) | −31.64 | 18.35 | „ |
| 31.172 | 402.45 | „ | −24.71 | 28.15 | „ |
| 37.119 | 500.74 | „ | −18.61 | 40.20 | „ |
| 43.574 | 627.97 | „ | −12.91 | 55.13 | „ |
| 48.131 | 732.12 | „ | − 7.30 | 74.07 | „ |
| 48.621 | 744.10 | „ | − 1.94 | 96.99 | „ |
| 49.073 | 755.30 | „ | + 4.46 | 131.78 | „ |
| 49.587 | 768.07 | „ | 9.32 | 164.63 | „ |
| 50.031 | 779.47 | „ | 14.24 | 204.39 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 49°2 | Jacobs and Parks (1934) | 49°26 | Kay (1947) |
| 49°2 | Fenske, Braun, Wiegand, Quiggle, McCormick and Rank (1947) | 49°262 | Willingham, Taylor, etc. (1945) |
| | | 49°262 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 49°20 | Wibaut, Hoog, Langedijk, Overhoff and Smittenberg (1939) | 49°3 | B.E. (1937) and Lecat (passim) |
| | | 49°35 | Chavanne and Van Risseghem (1922) |
| | | 49°37 | Thiry (1925) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°4004 | Forziati, Glasgow Jr., etc.(1946) | 0°402 | Willingham, Taylor, etc. (1945) |

*Freezing point*

| | | | |
|---|---|---|---|
| −93°47 | Aston, Fink and Schumann (1943) | −93°8 | Glasgow Jr., Murphy, Willingham and Rossini (1946) |
| −93°77 | Streiff, Murphy, Zimmerman, Sedlak, Soule, Willingham and Rossini (1947) | −93°917 | Forziati, Glasgow Jr., etc.(1946) |
| | | −94°1 | Jacobs and Parks (1934) |

*Triple point:* −93°45 Douslin and Huffman (1946)

*Transition points*

| | | |
|---|---|---|
| I −150°77 | II −135°08 | Douslin and Huffman (1946) |
| I −150°77 | II −135°09 | Aston, Fink and Schumann (1943) |

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 16°6 | B.E. (1937) |
| | 16°8 | Thiry (1925) |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.76498 | B.E. (1937) | 20 | 0.74542 | Wibaut, Hoog, etc. (1939) |
| 15 | 0.75033 | „ | 25 | 0.74040 | „ |
| 30 | 0.73572 | „ | 20 | 0.74538 | Forziati, Glasgow Jr., etc. |
| 0 | 0.7646 | Chavanne and Van Risseghem (1922) | 25 | 0.74045 | „ (1946) |
| | | | 20 | 0.7453 | Eykman (1906) |
| 15 | 0.7503 | „ | 20 | 0.7454 | Kay (1947) |
| 15 | 0.7505 | Thiry (1925) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 460 | B.E. (1937) |
| 30 | 388 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 23.16 | B.E. (1937) | 20 | 22.42 | Wibaut, Hoog, etc. (1939) |
| 20 | 22.57 | „ | | | |
| 30 | 21.17 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40668 | 1.40702 | 1.40910 | 1.40927 | 1.41318 | 1.41418 | 1.41723 | — | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00052 | 53 | — | 54 | 55 | 55 | 55 | — | „ |
| 20 | — | 1.40442 | 1.40649 | — | — | 1.41145 | — | 1.41546 | Wibaut, Hoog, etc. |
| 25 | — | 1.40157 | 1.40370 | — | — | 1.40855 | — | 1.4261 | „ (1939) |
| $\frac{dn}{dt}$ | — | 0.00057 | 56 | — | — | 58 | — | 57 | „ |
| 20 | — | — | 1.40646 | — | — | — | — | — | Forziati, Glasgow |
| 25 | — | — | 1.40362 | — | — | — | — | — | Jr., etc. (1946) |
| $\frac{dn}{dt}$ | — | — | 0.00057 | — | — | — | — | — | „ |
| 20 | — | — | 1.4065 | — | — | — | — | — | Fenske, Braun, etc. (1947) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. I −180.16 | 0.193 | C. III −123.16 | 0.300 | −59.06 | 0.353 | Jacobs and |
| −174.16 | 0.201 | −117.66 | 0.300 | −36.06 | 0.370 | Parks (1934) |
| −166.86 | 0.210 | −107.16 | 0.299 | −30.86 | 0.372 | „ |
| −159.06 | 0.219 | −101.86 | 0.299 | −26.56 | 0.378 | „ |
| C. II −144.76 | 0.318 | L. − 87.16 | 0.339 | −21.56 | 0.382 | „ |
| −128.86 | 0.302 | − 81.46 | 0.343 | + 3.24 | 0.407 | „ |
| −140.46 | 0.315 | − 75.56 | 0.344 | 11.64 | 0.419 | „ |
| | | − 70.06 | 0.347 | 15.64 | 0.424 | „ |
| | | − 64.46 | 0.351 | 19.54 | 0.429 | „ |
| C. I −260.36 | 0.00779 | C. III −131.82 | 0.3062 | Aston, Fink and Schumann (1943) (M.W. 70.130) | | |
| −249.16 | 0.04225 | −121.96 | 0.3049 | „ | | |
| −238.56 | 0.07693 | −111.41 | 0.3029 | „ | | |
| −227.06 | 0.1118 | − 99.91 | 0.3007 | „ | | |
| −217.46 | 0.1355 | L. − 89.08 | 0.3411 | „ | | |
| −209.86 | 0.14963 | — 78.38 | 0.3455 | „ | | |
| −200.55 | 0.16609 | − 61.02 | 0.3565 | „ | | |
| −191.16 | 0.17968 | − 50.03 | 0.3650 | „ | | |
| −178.77 | 0.19852 | − 38.29 | 0.3741 | „ | | |
| −167.12 | 0.21292 | − 32.46 | 0.3791 | „ | | |
| C. II −149.45 | 0.3234 | − 20.33 | 0.3885 | „ | | |
| −140.25 | 0.3219 | − 5.15 | 0.4014 | „ | | |
| | | + 0.69 | 0.4074 | „ | | |
| | | 12.23 | 0.4241 | „ | | |
| | | 18.24 | 0.4305 | „ | | |

*Specific heat* (continued)

| | t° | $c_p$ | | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. I | −261.28 | 0.00623 | | −98.58 | 0.30401 | Douslin and Huffman (1946) |
| | −250.98 | 0.03418 | L. | −87.41 | 0.34255 | „ (M.W. 70.130) |
| | −241.93 | 0.06603 | | −77.96 | 0.34627 | „ |
| | −231.10 | 0.09126 | | −67.62 | 0.35138 | „ |
| | −218.22 | 0.1336 | | −55.56 | 0.35906 | „ |
| | −211.65 | 0.14723 | | −45.68 | 0.36578 | |
| | −200.52 | 0.16632 | | −35.97 | 0.37254 | (Values at other temperatures: see authors) |
| | −187.69 | 0.18550 | | −26.44 | 0.38025 | |
| | −180.84 | 0.19471 | | −17.09 | 0.38851 | „ |
| | −173.86 | 0.20341 | | − 7.93 | 0.39787 | „ |
| | −159.34 | 0.22170 | | + 1.05 | 0.40672 | „ |
| C. III | −130.09 | 0.30811 | | 9.87 | 0.41526 | „ |
| | −122.85 | 0.30590 | | 26.96 | 0.43416 | „ |
| | −109.33 | 0.30411 | | | | „ |

| | | |
|---|---|---|
| *Heat of vaporisation* | 25° 99.631 cal 15°/g | Douslin and Huffman (1946) |

| *Heat of transition* cal 15°/g | | *Heat of melting* cal 15°/g | |
|---|---|---|---|
| —150°77 : 16.625 | —135°09 : 1.1815 | 2.0555 | Aston, Fink and Schumann (1943) |
| —150°77 : 16.645 | —135°08 : 1.1738 | 2.0753 | Douslin and Huffman (1946) |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 11215.4 cal 15°/g | Johnson, Prosen and Rossini (1946) (M.W. 70.130) |

## METHYL-*cyclo*-PENTANE $C_5H_9—CH_3$

Prepared by hydrogenation of methyl-*cyclo*-pentene, B.E. (1937), or by isomerisation of *cyclo*-hexane with $Al_2O_3$. Wibaut, Hoog, Langedyk, Overhoff and Smittenberg (1939).

**Constants:** B.E. (1937)

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 259.61 | 37364 | 0.264 | Kay (1947) |

*Saturated vapour pressure:* SCHMITT (1934)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −16.30 | 16.80 | 21.25 | 116.3 | 50.23 | 369.9 |
| 0 | 41.8 | 31.06 | 177.4 | 60.45 | 525.6 |
| 10.85 | 72.1 | 38.45 | 238.3 | 65.90 | 626.9 |
| 19.90 | 109.3 | 41.30 | 265.9 | 72.87 | 779.6 |
| 21.20 | 116.1 | 46.13 | 318.8 | 76.65 | 873.5 |

*Boiling point*

| | | | |
|---|---|---|---|
| 71°8 | HICKS-BRUUN and BRUUN (1931) | 72°00 | $\frac{dt}{dp}$ *(10 mm)* B.E. (1937) and LECAT (passim) |
| 71°82 | KAY (1947) | | |
| 71°89 | SCHMITT (1934) | 72°00 | CHAVANNE and SIMON (1919) |

*Freezing point:* −142°445 GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946)
*Triple point:* −142°43 DOUSLIN and HUFFMAN (1946)

*Critical solution point* in $C_6H_5NH_2$

| | | | |
|---|---|---|---|
| 34°0 | WIBAUT, HOOG, etc. (1939) | 34°7 | HICKS-BRUUN and BRUUN (1931) |
| 34°70 | B.E. (unp.) | 35° | CHAVANNE and SIMON (1919) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.76737 | B.E. (1937) | 20 | 0.7487 | HICKS-BRUUN and BRUUN (1931) |
| 15 | 0.75343 | „ | | | |
| 30 | 0.73948 | „ | 20 | 0.74869 | WIBAUT, HOOG, etc. (1939) |
| 15 | 0.7533 | CHAVANNE and SIMON (1919) | 25 | 0.74397 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 534 | B.E. (1937) |
| 30 | 448 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 22.74 | B.E. (1937) | 20 | 22.17 | WIBAUT, HOOG, etc. (1939) |
| 20 | 22.18 | „ | | | |
| 30 | 21.06 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40975 | 1.41023 | — | 1.41254 | 1.41649 | 1.41760 | 1.42064 | — | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00050 | 50 | — | 51 | 51 | 52 | 51 | — | „ |
| 20 | — | 1.40764 | 1.40983 | — | — | 1.41488 | — | 1.41896 | Wibaut, etc. (1939) |
| 25 | — | 1.40493 | 1.40713 | — | — | 1.41210 | — | 1.41621 | „ |
| $\frac{dn}{dt}$ | — | 0.00054 | 54 | — | — | 55 | — | 55 | „ |
| 20 | — | — | 1.4098 | — | — | — | — | — | Hicks-Bruun and Bruun (1931) |

*Specific heat:* Douslin and Huffman (1946) (M.W. 84.156)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.36 | 0.00959 | −180.71 | 0.18390 | −103.11 | 0.36072 | −19.12 | 0.40906 |
| −252.24 | 0.03246 | −172.22 | 0.19476 | − 92.60 | 0.36445 | −11.64 | 0.41525 |
| −240.35 | 0.07191 | −158.36 | 0.21377 | − 82.22 | 0.36783 | − 1.66 | 0.42415 |
| −230.16 | 0.1002 | −149.34 | 0.23143 | − 71.99 | 0.37269 | + 8.11 | 0.43355 |
| −223.98 | 0.1144 | L. −137.06 | 0.35484 | − 61.90 | 0.37843 | 18.13 | 0.44441 |
| −210.07 | 0.13934 | −128.27 | 0.35545 | − 51.99 | 0.38458 | 28.36 | 0.45347 |
| −203.94 | 0.15062 | −117.41 | 0.35741 | − 42.23 | 0.39068 | 34.36 | 0.46069 |
| −189.63 | 0.17231 | −111.52 | 0.35842 | − 32.15 | 0.39844 | | |

(Values at other temperatures: see authors)

| | | |
|---|---|---|
| *Heat of melting* | 19.677 cal 15°/g | Douslin and Huffman (1946) |
| *Heat of combustion* | 25° ($c_p$) 11173.4 „ | Moore and Parks (1939) |
| | 25° ($c_p$) 11183 „ | Johnson, Prosen and Rossini (1946) (M.W. 84.156) |

## ETHYL-*cyclo*-PENTANE $C_5H_9 . C_2H_5$

### Constants

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 296.30 | 33526 | 0.262 | Kay (1947) |

*Boiling point:* 103°45 Kay (1947)

*Melting point*

| | |
|---|---|
| −138·435 | Streiff, Murphy, Zimmerman, Sedlak, Soule, Willingham and Rossini (1947) |
| −138·460 | Glasgow Jr., Murphy, Willingham and Rossini (1946) |

*Density:* 20° 0.7632 Grosse and Wackher (1939)

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 11178.2 cal 15° g | Johnson, Prosen and Rossini (1946) (M.W. 98.182) |

## *n*-PROPYL-*cyclo*-PENTANE $C_5H_9 \cdot n\text{-}C_3H_7$

*Heat of combustion:* Johnson, Prosen and Rossini (1946); *heat of vaporisation:* Osborne and Ginnings (1947)

## *n*-BUTYL-*cyclo*-PENTANE $C_5H_9—n\text{-}C_4H_9$

**Constants**

*Boiling point*

| | |
|---|---|
| 156°7 | Crane, Boord and Henne (1945) |
| 156°8 | Thiry (1925) and Chavanne and Becker (1927) |

*Freezing point:* −108°2 Timmermans; Chavanne and Becker (1927)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 50°5 | Chavanne and Simon (1919) |
| | 51°1 | Thiry (1925) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 14.95 | 0.7887 | Chavanne and Becker | 15 | 0.7887 | Thiry (1925) |
| 20.2 | 0.7848 | ,, (1927) | 20 | 0.7840 | Crane, Boord and Henne (1945) |

*Refractive index*

| t° | Hα | D | Hβ | |
|---|---|---|---|---|
| 20 | — | 1.4318 | — | Crane, Boord and Henne (1945) |
| 20.35 | 1.4292 | 1.4314 | 1.4366 | Chavanne and Becker (1927) |

## DIMETHYL-*cyclo*-PENTANES $C_5H_8(CH_3)_2$

1,2-*cis* and -*trans*

*Boiling, melting* and *critical solution points, density, viscosity* and *refractive index* CHIURDOGLU (1938—1944)

1,1- and 1,2-*cis*

*Melting point* STREIFF, MURPHY, ZIMMERMAN, SEDLAK, SOULE, WILLINGHAM and ROSSINI (1947)

1,2-*trans*

*Melting point* GLASGOW Jr. (1940)

## *Cyclo*-PENTENE $C_5H_8$

**Constants:** HUFFMAN, EATON and OLIVER (1948)

*Triple point:* —135°03 „

*Freezing point:* —135°082 STREIFF, MURPHY, SEDLAK, WILLINGHAM and ROSSINI (1946)

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 0 | 0.79229 | 15 | 365 | 15 | 23.28 | LA BRUYÈRE (unp.) |
| 15 | 0.77673 | 30 | 312 | 20 | 22.65 | „ |
| 30 | 0.76103 | | | 30 | 21.32 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | He v. | |
|---|---|---|---|---|---|---|
| 15 | 1.42228 | 1.42266 | 1.42542 | 1.43072 | 1.43609 | LA BRUYÈRE (unp.) |
| $\frac{dn}{dt}$ | 0.00055 | 55 | 55 | 56 | 58 | „ |

*Specific heat:* HUFFMAN, EATON and OLIVER (1948) (M.W. 68.114)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. I —261.07 | 0.0112 | C. II —181.17 | 0.27185 | —92.51 | 0.34826 | —26.18 | 0.38278 |
| —250.79 | 0.04735 | —173.68 | 0.26936 | —84.84 | 0.35007 | —16.39 | 0.39102 |
| —239.80 | 0.08789 | —148.67 | 0.27696 | —69.17 | 0.35584 | — 6.78 | 0.39890 |
| —231.11 | 0.1129 | —141.39 | 0.28335 | —60.66 | 0.35993 | + 2.66 | 0.40762 |
| —221.05 | 0.1399 | L. —109.55 | 0.34616 | —46.34 | 0.36838 | 19.64 | 0.42430 |
| —208.90 | 0.1714 | —100.60 | 0.34683 | —36.17 | 0.37515 | 26.68 | 0.43216 |
| —202.10 | 0.1884 | | | | | | |
| —190.27 | 0.23975 | | | | | | |
| —187.16 | 0.28170 | | | | | | |

(Values at other temperatures: see authors)

| | | |
|---|---|---|
| *Heat of melting* | 11.80 cal 15°/g | HUFFMAN, EATON and OLIVER (1948) |
| *Heat of transition* | 1.682 „ | „ |

## 1-METHYL-*cyclo*-PENTENE $C_5H_7—CH_3$

Prepared by dehydration of the methyl-*cyclo*-pentanol obtained from *cyclo*-pentanone.

**Constants:** B.E. (1937)

*Boiling point:* 75.85 $\frac{dt}{dp}$ *(10 mm)* 0°45 *Freezing point:* −123.35

*Density*

| t° | d |
|---|---|
| 0 | 0.79863 |
| 15 | 0.78452 |
| 30 | 0.77048 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 418 |
| 30 | 359 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 24.32 |
| 20 | 23.82 |
| 30 | 22.58 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.43191 | 1.43237 | 1.43519 | 1.43536 | 1.44076 | 1.44239 | 1.44657 |
| $\frac{dn}{dt}$ | 0.00051 | 51 | — | 52 | 53 | 54 | 54 |

Crane, Boord and Henne (1945) have studied a series of alkylpentenes.

## 1,5 and 1,2-DIMETHYL-*cyclo*-PENTENES $C_5H_6(CH_3)_2$

Prepared by dehydration of 1,2 dimethyl-*cyclo*-pentanol 1, by means of formic acid.

**Constants:** Chiurdoglu (1938)

| | | 1,5— | 1,2— |
|---|---|---|---|
| *Boiling point* | | 95°48—95°50 | 105°03 |
| *Freezing point* | | −118°1 Timmermans | −91°3 Timmermans |
| *Density* | 0° | 0.79855 | 0.81283 |
| | 15° | 0.78512 | 0.79948 |
| | 20° | 0.78055 | 0.79501 |
| | 30° | 0.77155 | 0.78612 |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 512.7 | 535.1 |
| | 30° | 437.4 | 457.5 |
| *Refractive index* | 20° | | |
| | Hα | 1.43030 | 1.44139 |
| | He y | 1.43311 | 1.44436 |
| | Hβ | 1.43972 | 1.45142 |
| | Hγ | 1.44508 | 1.45717 |

## *Cyclo*-HEXANE $C_6H_{12}$

The compounds of the *cyclo*-hexane series are prepared by hydrogenation of the corresponding benzene derivatives. Traces of benzene in the *cyclo*-hexane are eliminated by nitration followed by fractional fusion in order to get rid of traces of paraffins. The criteria of purity are the freezing point and the critical solution point in aniline.

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 280.2 | — | 0.2718 | Simon (1938) |
| 280.7 | — | — | Fischer and Reichel (1943) |
| 281.0 | 30835 | — | Rotinjanz and Nagornow (1934) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. −4.51 | 20.55 | 4.03 | 34.05 | 10.03 | 48.45 | Rotinjanz and Nagornow |
| −2.77 | 23.10 | 5.09 | 36.30 | 10.95 | 50.90 | „ (1924–34) |
| −1.02 | 25.65 | 6.14 | 38.70 | 12.10 | 54.00 | „ |
| +1.13 | 28.80 | L. 6.90 | 40.60 | 14.08 | 59.60 | „ |
| 2.27 | 30.80 | 9.12 | 46.20 | 16.10 | 65.70 | „ |
| 3.33 | 32.75 | | | | | „ |
| L. 6.32 | 40.41 | 13.62 | 57.73 | 20.96 | 81.83 | Aston, Szasz and Fink |
| 9.88 | 48.16 | 17.64 | 69.96 | — | — | „ (1943) |
| 23.72 | 90.96 | 36.81 | 161.23 | 80.74 | 757.50 | Dejardin (1919) |
| 25.55 | 98.84 | 38.50 | 172.96 | 80.82 | 759.30 | „ |
| 29.14 | 116.05 | 42.25 | 201.33 | 80.89 | 760.76 | „ |
| 32.68 | 135.43 | 80.35 | 750.00 | 81.01 | 763.50 | „ |
| 34.06 | 143.80 | 80.66 | 755.59 | 81.06 | 764.50 | „ |
| 19.915 | 77.28 | 44.108 | 217.22 | 79.502 | 732.13 | Willingham, Taylor, |
| 22.657 | 87.72 | 48.991 | 261.73 | 80.037 | 744.13 | Pignocco and Rossini |
| 26.347 | 103.67 | 54.884 | 324.96 | 80.534 | 755.32 | „ (1945) |
| 30.556 | 124.65 | 60.969 | 402.48 | 81.093 | 768.09 | „ |
| 34.821 | 149.39 | 67.467 | 500.76 | 81.582 | 779.49 | „ |
| 38.798 | 175.91 | 74.520 | 627.98 | | | „ |
| 28.87 | 114.6 | 51.28 | 281.9 | 74.29 | 620.0 | Schmitt (1934) |
| 33.51 | 139.8 | 61.26 | 403.3 | 80.68 | 756.3 | „ |
| 47.89 | 249.5 | 69.71 | 535.5 | | | „ |
| 30 | 121.60 | 50 | 271.80 | 70 | 543.95 | Scatchard, Wood and |
| 40 | 184.61 | 60 | 389.29 | 80 | 743.27 | Mochel (1939) |

The measurements of ROTINJANZ and NAGORNOW (1934) seem to be made carefully, but some of their values do not agree well with those of other authors.

*Boiling point*

| | | | |
|---|---|---|---|
| 80°70 | GRIMM (1929) | 80°77 | THIRY (1925) |
| 80°738 | WILLINGHAM, TAYLOR, etc. (1945) | 80°80 | B.E. (1926) |
| 80°738 | FORZIATI, GLASGOW Jr., WILLINGHAM and ROSSINI (1946) | 80°8 | RICHARDS and BARRY (1915) |
| | | 80°8 | HARRISON and BERG (1946) |
| 80°739 | SCATCHARD, WOOD and MOCHEL (1939) | 80°84 | SCHMITT (1934) |
| | | 80°84 | GJALDBAEK and HILDEBRAND (1949) |
| 80°75 | ROTINJANZ and NAGORNOW (1934) | | |
| 80°75 | LECAT (passim) | 80°85 | DEJARDIN (1919) |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°434 | SCHMITT (1934) | 0°444 | DEJARDIN (1919) |
| 0°437 | WILLINGHAM, TAYLOR, etc. (1945) | 0°45 | B.E. (1926) |
| 0°44 | GRIMM (1929) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| 6°48 | ECKFELDT and LUCASSE (1943) | 6°554 | GLASGOW Jr., MURPHY, WILLINGHAM and ROSSINI (1946) |
| 6°541 | FORZIATI, GLASGOW Jr., etc.(1946) | | |
| 6°55 | THIRY (1925) | 6°63 | ROTINJANZ and NAGORNOW (1924–34) |
| 6°55 | B.E. (unp.) corr. B.E. (1926) | | |
| | | 6°68 | ASTON, SZASZ and FINK (1943) |

*Triple point:* 6°32/40.41 mm ASTON, SZASZ and FINK (1943)

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 6.55 | 1 | 35.00 | 546 | DEFFET (1935) |
| 10.00 | 66.5 | 40.00 | 647 | ,, |
| 15.00 | 163 | 45.00 | 748 | ,, |
| 20.00 | 260 | 50.00 | 847 | ,, |
| 25.00 | 355 | 55.00 | 948 | ,, |
| 30.00 | 449 | | | ,, |

*Transition point:* −87°07 ASTON, SZASZ and FINK (1943)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5NH_2$ | 31°0 | B.E. (1926) |

*Isotherms* between 2° and 300°, and from 4 to 100 atm: ROTINJANZ and NAGORNOW (1934)

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.78310 | B.E. (1926) | 7.00 | 0.79063 | ROTINJANZ and NAGORNOW |
| 30 | 0.76928 | „ | 16.12 | 0.78221 | „ (1934) |
| 60 | 0.74060 | „ | 25.08 | 0.77384 | „ |
| 15.00 | 0.78315 | MASSART (1936) | 40.21 | 0.75942 | „ |
| 33.15 | 0.76616 | „ | 50.95 | 0.74416 | „ |
| 43.35 | 0.75454 | „ | 78.05 | 0.72215 | „ |
| 64.05 | 0.73661 | „ | 16.0 | 0.7823 | HÜCKEL and HARDER |
| 79.20 | 0.72160 | „ | 46.0 | 0.7540 | „ (1947) |
| 99.20 | 0.70080 | „ | 20 | 0.77853 | FORZIATI, GLASGOW Jr., |
| 13.5 | 0.7844 | EYKMAN (1906) | 25 | 0.77389 | „ etc. (1946) |
| 13.5 | 0.7843 | SABATIER and SENDERENS (1905) | 20.0 | 0.7783 | MICHIELEWICZ (1938) |
| | | | 25.0 | 0.77383 | SCATCHARD, WOOD and MOCHEL (1939) |
| 15.0 | 0.7830 | CHAVANNE and VAN RISSEGHEM (1922) | 30.0 | 0.76914 | „ |
| 15 | 0.7830 | THIRY (1925) | 30.0 | 0.7692 | CHAVANNE and VAN RYSSEGHEM (1922) |
| 15.9 | 0.7824 | EYKMAN (1909) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 15^5$ | |
|---|---|---|---|---|---|
| 15 | 1056 | B.E. (1926) | 17 | 1030 | DRAPIER (1911) |
| 30 | 820 | „ | 22 | 930 | „ |
| 60 | 534 | „ | 27 | 860 | „ |
| | | | 32 | 790 | „ |
| | | | 35 | 750 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 25.64 | HENNAUT-ROLAND and LEK | 20 | 25.2 | SMITH (1944) |
| 20 | 24.99 | „ (1931) | | | |
| 30 | 23.82 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42633 | 1.42670 | 1.42886 | 1.42914 | 1.43348 | 1.43430 | 1.43762 | 1.43870 | B.E. (1926) |
| $\frac{dn}{dt}$ | — | 0.00052 | 52 | 52 | — | 54 | — | — — | ,, |
| 13.5 | — | 1.42777 | — | — | — | 1.43531 | — | 1.43972 | SABATIER and SENDERENS (1905) |
| 44.6 | — | 1.41056 | — | — | — | 1.41785 | — | 1.42214 | |
| $\frac{dn}{dt}$ | — | 0.00055 | — | — | — | 56 | — | 56 | ,, |
| 20 | — | 1.42405 | 1.42630 | — | — | 1.43157 | — | 1.43592 | WIBAUT, etc. (1939) |
| 25 | — | 1.42134 | 1.42358 | — | — | 1.42878 | — | 1.43310 | ,, |
| $\frac{dn}{dt}$ | — | 0.00054 | 54 | — | — | 55 | — | 56 | ,, |
| 20 | — | — | 1.42623 | — | — | — | — | — | FORZIATI, etc.(1946) |
| 25 | — | — | 1.42354 | — | — | — | — | — | ,, |
| $\frac{dn}{dt}$ | — | — | 0.00054 | — | — | — | — | — | ,, |
| 14.8 | — | — | 1.4292 | — | — | — | — | — | HÜCKEL and HARDER (1947) |
| 16.1 | — | 1.42626 | — | — | — | 1.43381 | — | 1.43820 | EYKMAN (1906) |
| 20 | — | 1.4242 | — | — | — | — | — | — | MICHIELEWICZ(1938) |
| 20 | — | — | 1.4263 | — | — | — | — | — | HARRISON and BERG (1946) |

*Dielectric constant*

| t° | ε | t° | ε | t′ | ε | |
|---|---|---|---|---|---|---|
| 6.5 | 2.044 | 16.75 | 2.028 | 31.5 | 2.005 | HADAMARD (1937) |
| 7.15 | 2.0435 | 17.35 | 2.027 | 34.8 | 2.0015 | ,, |
| 7.6 | 2.0425 | 18.7 | 2.025 | 37.0 | 1.996 | ,, |
| 14.7 | 2.031 | 23.3 | 2.0175 | 38.15 | 1.9945 | ,, |
| 15.4 | 2.030 | 28.1 | 2.010 | | | ,, |
| 5 | 2.046 | 15 | 2.034 | 25 | 2.0199 | LE FÈVRE (1938) |
| 25 | 2.012 | | | | | PIETTE (unp.) |

**Heat constants**

*Specific heat*

| | t° | $c_p$ | | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| L. | 22.50 | 0.506 | | 41.40 | 0.518 | DEJARDIN (1919) |
| | 29.70 | 0.512 | | 50 | 0.524 | „ |
| C. I | −260.43 | 0.0067 | | −111.86 | 0.2381 | ASTON, SZASZ and FINK (1943 |
| | −251.80 | 0.0288 | | −101.84 | 0.2528 | „ (M.W. 84.156) |
| | −241.61 | 0.0575 | | − 92.33 | 0.2683 | „ |
| | −229.97 | 0.0871 | C. II | − 81.86 | 0.3066 | „ (Values at other |
| | −219.98 | 0.105 | | − 71.70 | 0.3106 | „ temperatures: see |
| | −209.29 | 0.1211 | | − 61.18 | 0.3167 | „ authors) |
| | −200.26 | 0.1337 | | − 49.75 | 0.3250 | „ |
| | −190.29 | 0.1462 | | − 38.95 | 0.3331 | „ |
| | −179.71 | 0.1589 | | − 18.37 | 0.3510 | „ |
| | −170.03 | 0.1691 | | − 7.76 | 0.3638 | „ |
| | −160.96 | 0.1799 | | − 2.03 | 0.3674 | „ |
| | −151.30 | 0.1906 | L. | + 11.73 | 0.4333 | „ |
| | −137.00 | 0.2068 | | 15.63 | 0.4382 | „ |
| | −121.67 | 0.2243 | | 19.30 | 0.4411 | „ |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 93.821 cal 15°/g | OSBORNE and GINNINGS (1947) |
| | „ | 94.82 „ | ASTON, SZASZ and FINK (1943) |
| *Heat of melting* | | 7.466 „ | „ |
| *Heat of transition* | | 19.006 „ | „ |
| *Heat of combustion* | 25° | ($c_p$) 11126.7 „ | MOORE and PARKS (1939) |
| | 25° | ($c_p$) 11132.6 „ | JOHNSON, PROSEN and ROSSINI (1946) (M.W. 84.156) |

## METHYL-*cyclo*-HEXANE $C_6H_{11}-CH_3$

In order to obtain pure methyl-*cyclo*-hexane, it is necessary to hydrogenate toluene which has been purified by sulphonation to get rid of the paraffins. Otherwise, it would be difficult to eliminate the latter from the methyl-*cyclo*-hexane.

**Constants:** B.E. (1926) — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 299.13 | 34.322 | — | KAY (1947) |
| 299.5 | — | 0.2666 | SIMON (1938) |

*Boiling point*

| | | | |
|---|---|---|---|
| 100°8 | Hicks-Bruun and Bruun (1932) | 100°83 | Parks and Huffman (1930) |
| 100°8 | Bromiley and Quiggle (1933) | 100°934 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 100°8 | Harrison and Berg (1946) | | |
| 100°80 | Richards and Hargreaves (1944) | 100°94 | Kay (1947) |
| | | 100°95 | B.E. (unp.) corr. B.E. (1926) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°4671 | Farziati, Glasgow Jr., etc. | 0°49 | Wibaut, Hoog, etc. (1939) |
| 0°48 | B.E. (unp.) (1946) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −126°35 | Wibaut, Hoog, etc. (1939) | −126°591 | Forziati, Glasgow Jr., etc. (1946) |
| −126°4 | Timmermans, Van der Horst and Kamerlingh Onnes (1922) | −126°596 | Glasgow Jr., Murphy, Willingham and Rossini (1946) |
| −126°44 | Hicks-Bruun and Bruun (1932) | | |

*Triple point:* −126°58 Douslin and Huffman (1946)

*Critical solution point*

| | | |
|---|---|---|
| in $C_6H_5$–$NH_2$ | 41°0 | B.E. (1926) |
| | 41°0 | Hicks-Bruun and Bruun (1932) |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −95.1 | 0.86893 | Massart (1936) | 0.0 | 0.7868 | Chavanne and Van Ryssenhem (1922) |
| −63.5 | 0.84144 | ,, | | | |
| −45.2 | 0.82561 | ,, | 15.0 | 0.7737 | ,, |
| −22.9 | 0.80638 | ,, | 30.0 | 0.7606 | ,, |
| 0 | 0.78650 | ,, | 0 | 0.78650 | B.E. (1926) |
| 15.00 | 0.77340 | ,, | 15 | 0.77340 | ,, |
| 29.95 | 0.76046 | ,, | 30 | 0.76030 | ,, |
| 45.20 | 0.74702 | ,, | 16.3 | 0.7725 | Eykman (1906) |
| 60.70 | 0.73360 | ,, | 16.9 | 0.7718 | ,, |
| 79.75 | 0.71660 | ,, | 20 | 0.76925 | Hicks-Bruun and Bruun (1932) |
| 99.50 | 0.69825 | ,, | | | |
| 20 | 0.76944 | Wibaut, Hoog, etc. | 20 | 0.7693 | Bromiley and Quiggle (1933) |
| 25 | 0.76512 | ,, (1939) | | | |
| 25 | 0.76496 | Kretschmer and Wiebe (1949) | 20 | 0.76936 | Forziati, Glasgow Jr., etc. (1946) |
| | | | 25 | 0.76501 | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 777 | B.E. (1926) | 15 | 780 | Chavanne and Van Ryssegem (1922) |
| 30 | 639 | „ | 30 | 627 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 24.43 | Hennaut-Roland and Lek | 20 | 23.73 | Wibaut, Hoog, etc. (1939) |
| 20 | 23.82 | „ (1931) | 20 | 23.74 | Desreux (1935) |
| 30 | 22.72 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42293 | 1.42305 | 1.42555 | 1.42570 | 1.42997 | 1.43072 | 1.43440 | 1.43510 | B.E. (1926) |
| $\frac{dn}{dt}$ | — | 0.00047 | 47 | 47 | — | 48 | — | 49 | „ |
| 20 | — | 1.42085 | 1.42310 | — | — | 1.42836 | — | 1.43285 | Wibaut, Hoog, etc. |
| 25 | — | 1.41838 | 1.42063 | — | — | 1.42588 | — | 1.43022 | „ (1939) |
| $\frac{dn}{dt}$ | — | 0.00049 | 49 | — | — | 50 | — | 53 | „ |
| 20 | — | — | 1.42305 | — | — | — | — | — | Forziati, Glasgow Jr., etc. (1946) |
| 25 | — | — | 1.42056 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00050 | — | — | — | — | — | „ |
| 20 | — | — | 1.4230 | — | — | — | — | — | Harrison and Berg (1946) |
| 20 | — | — | 1.4231 | — | — | — | — | — | Marschner and Cropper (1946) |
| 20 | — | — | 1.42312 | — | — | — | — | — | B.E. (1949) |
| 20 | — | — | 1.4232 | — | — | — | — | — | Bromiley and Quiggle (1933) |
| 20 | — | — | 1.4234 | — | — | — | — | — | Hicks-Bruun and Bruun (1932) |
| 30 | — | — | 1.4182 | — | — | — | — | — | Richards and Hargraves (1944) |
| 25 | — | — | 1.42059 | — | — | — | — | — | Kretschmer and Wiebe (1949) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −173.96 | 0.162 | L. −121.76 | 0.339 | −43.76 | 0.389 | Parks and Huffman |
| −167.66 | 0.170 | −116.06 | 0.343 | −28.26 | 0.400 | ,, (1930) |
| −159.56 | 0.178 | −102.86 | 0.351 | −13.16 | 0.412 | ,, |
| −160.96 | 0.179 | − 90.56 | 0.359 | + 2.24 | 0.426 | ,, |
| −154.96 | 0.186 | − 73.76 | 0.368 | 12.04 | 0.436 | ,, |
| −148.66 | 0.196 | − 58.86 | 0.378 | 21.04 | 0.443 | ,, |
| −143.16 | 0.205 | | | | | ,, |
| C. −260.97 | 0.00794 | −222.23 | 0.09359 | L. −118.07 | 0.34314 | Douslin and Huffman (1946) (M.W. |
| −259.57 | 0.01039 | −217.34 | 0.1014 | −112.55 | 0.34599 | ,, 98.182) |
| −258.88 | 0.01179 | −215.09 | 0.10493 | −107.84 | 0.34793 | ,, |
| −257.13 | 0.01576 | −208.10 | 0.11549 | −102.40 | 0.35160 | ,, |
| −256.47 | 0.01720 | −201.29 | 0.12484 | − 97.79 | 0.35422 | ,, |
| −253.24 | 0.02538 | −195.25 | 0.13312 | − 92.42 | 0.35681 | ,, |
| −253.14 | 0.02562 | −188.75 | 0.14221 | − 86.96 | 0.36001 | ,, |
| −249.20 | 0.03605 | −181.80 | 0.15134 | − 75.36 | 0.36677 | ,, |
| −248.32 | 0.03666 | −174.51 | 0.16030 | − 64.00 | 0.37360 | ,, |
| −245.16 | 0.03839 | −166.32 | 0.17093 | − 51.95 | 0.38215 | ,, |
| −244.43 | 0.04661 | −157.10 | 0.18264 | − 26.88 | 0.40200 | ,, |
| −240.83 | 0.05724 | −147.47 | 0.19458 | − 13.94 | 0.41305 | ,, |
| −240.77 | 0.05743 | −137.53 | 0.20716 | − 0.49 | 0.42523 | ,, |
| −235.56 | 0.06905 | −135.77 | 0.20923 | + 12.60 | 0.43731 | ,, |
| −229.96 | 0.08004 | −130.65 | 0.21774 | | | ,, |
| −223.74 | 0.09115 | | | | | ,, |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 86.071 cal 15°/g | Osborne and Ginnings (1947) |
| *Heat of melting* | | 16.24 ,, | Parks and Huffman (1930) |
| | | 16.432 ,, | Douslin and Huffman (1946) |
| *Heat of combustion* | 25° ($c_p$) | 11113.8 ,, | Johnson, Prosen and Rossini (1946) (M.W. 98.182) |

*Iso*-PROPYL-*cyclo*-HEXANE $C_6H_{11}{-}CH(CH_3)_2$

*Boiling, freezing* and *critical solution points, density* and *refractive index:* Wibaut, Hoog, Langedijk, Overhoff and Smittenberg (1939).

*Freezing point:* Streiff, Murphy, Zimmerman, Sedlak, Soule, Willingham and Rossini (1947).

## ETHYL-*cyclo*-HEXANE $C_6H_{11}—C_2H_5$

**Constants:** Huffman, Todd and Oliver (1949)

*Freezing point:* −111°3194

*Specific heat:* (M.W. 112.208)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −261.16 | 0.009946 | −183.26 | 0.15378 | L. −105.81 | 0.34868 |
| −253.43 | 0.02881 | − 169.29 | 0.16919 | − 93.21 | 0.35578 |
| −242.78 | 0.05597 | −163.16 | 0.17637 | − 80.09 | 0.36293 |
| −231.40 | 0.08043 | −149.99 | 0.19188 | − 49.82 | 0.38368 |
| −219.36 | 0.10214 | −140.61 | 0.20265 | − 8.03 | 0.41874 |
| −212.26 | 0.11315 | −132.57 | 0.21217 | + 6.24 | 0.43214 |
| −198.32 | 0.13254 | −125.01 | 0.22109 | + 26.03 | 0.45225 |

(other values, see authors)

*Heat of vaporisation:* (25°) 86.207 cal 15°/g Osborne and Ginnings (1947)

*Heat of melting:* 17.750 „ Huffman, Todd and Oliver (1949)

## 1,1 and 1,2 *trans*-DIMETHYL-*cyclo*-HEXANES $C_6H_{10}(CH_3)_2$

1,2-Dimethyl-*cyclo*-hexane is prepared by hydrogenation of dimethylhydroresorcin. The other dimethyl-*cyclo*-hexanes are obtained by hydrogenation of the corresponding xylenes.

**Constants:** Miller (1935)

| | 1,1-dimethyl | | | 1,2-dimethyl *trans* | | |
|---|---|---|---|---|---|---|
| *Boiling point* | 119°8 | | | 123°70 | | |
| *Freezing point* | −33°349 | | | −88°172 Huffman, Todd and Oliver (1949) | | |
| | −33°54 | | | −88°180 Streiff, Murphy, Zimmerman, Sedlak, Soule, Willingham and Rossini (1947) | | |
| | −34°1 | | | −89°4 Miller (1935) | | |
| *Transition point* | −120°01 | | | — Huffman Todd and Oliver (1949) | | |
| *Critical solution point in* $C_6H_5$–$NH_2$ | 45°4 | | | 48°3 | | |
| *Density* 0° | 0.79709 | | | 0.79188 | | |
| 20° | 0.78073 | | | 0.77601 | | |
| *Viscosity* $\eta \cdot 10^5$ 15° | 1200 | | | 863 | | |
| 30° | 998 | | | 697 | | |
| *Refractive index* | 18°8 | 26°4 | $\frac{dn}{dt}$ | 18°8 | 26°4 | $\frac{dn}{dt}$ |
| He r. | 1.42680 | 1.42359 | 0.00042 | 1.42493 | 1.42171 | 0.00042 |
| He y. | 1.42959 | 1.42635 | 43 | 1.42768 | 1.42443 | 43 |
| He v. | 1.43822 | 1.43489 | 44 | 1.43641 | 1.43331 | 41 |

**Heat Constants**: Huffman, Todd and Oliver (1949)

*Specific heat:* (M.W. 112.208)

| 1,1-dimethyl | | | | 1,2-dimethyl *trans* | | | |
|---|---|---|---|---|---|---|---|
| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
| C. −259.06 | 0.01347 | C. II −119.01 | 0.29664 | C. −261.17 | 0.00737 | −113.84 | 0.23398 |
| −254.18 | 0.02635 | − 83.12 | 0.32495 | −253.67 | 0.02425 | −111.70 | 0.23591 |
| −243.19 | 0.05450 | − 55.91 | 0.34837 | −242.66 | 0.05200 | L. − 89.48 | 0.35294 |
| −230.28 | 0.07892 | − 40.54 | 0.36301 | −221.86 | 0.09227 | − 71.31 | 0.36451 |
| −222.50 | 0.09089 | L. − 30.42 | 0.39297 | −211.03 | 0.10898 | − 48.11 | 0.37962 |
| −211.40 | 0.10671 | − 22.59 | 0.39946 | −199.47 | 0.12564 | − 24.83 | 0.39782 |
| −197.47 | 0.12528 | − 12.30 | 0.40913 | −181.07 | 0.15115 | − 4.40 | 0.41663 |
| −185.67 | 0.14140 | − 2.24 | 0.41870 | −172.54 | 0.16181 | + 2.75 | 0.42351 |
| −172.11 | 0.15910 | + 7.62 | 0.42803 | −162.46 | 0.17460 | 11.67 | 0.43213 |
| −161.00 | 0.17385 | 30.37 | 0.45152 | −152.70 | 0.18690 | 20.45 | 0.44112 |
| −151.71 | 0.18606 | | | −142.24 | 0.19979 | 28.28 | 0.44964 |
| −142.12 | 0.19857 | | | −132.50 | 0.21217 | | |
| | | | | −123.93 | 0.22202 | (other values, see | |
| | | | | −117.42 | 0.29966 | authors) | |
| *Heat of transition:* | | 12.747 cal 15°/g | | — | | | |
| *Heat of melting:* | | 4.308 „ | | 22.348 cal 15°/g | | | |

## 1,2-DIMETHYL-*cyclo*-HEXANE *cis* $C_6H_{10}(CH_3)_2$ *cis*

**Constants**

*Saturated vapour pressure:* Willingham, Taylor, Pignocco and Rossini (1945)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 49.185 | 47.65 | 67.742 | 103.66 | 93.548 | 261.76 | 128.315 | 732.11 |
| 53.413 | 57.42 | 72.533 | 124.67 | 100.258 | 324.96 | 128.926 | 744.08 |
| 57.094 | 67.25 | 77.402 | 149.44 | 107.192 | 402.45 | 129.491 | 755.27 |
| 60.429 | 77.29 | 81.921 | 175.90 | 114.600 | 500.73 | 130.125 | 767.98 |
| 63.543 | 87.73 | 87.974 | 217.18 | 122.639 | 627.94 | 130.684 | 779.38 |

*Boiling point*

| | |
|---|---|
| 129°728 | $\frac{dt}{dp}$ *(10 mm)* 0°4988 Forziati, Glasgow Jr., Willingham and Rossini (1946) |
| 130°04 | Miller (1935) |

*Freezing point*

| | | | |
|---|---|---|---|
| −49°882 | Huffman, Todd and Oliver (1949) | −50°1 | Miller (1935) |
| −50°00 | Streiff, Murphy, Zimmerman, Sedlak, Soule, Willingham and Rossini (1947) | −50°211 | Forziati, Glasgow Jr., Willingham and Rossini (1946) |

*Transition point:* −100.66 Huffman, Todd and Oliver (1949)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.81311 | Miller (1935) | 20 | 0.79627 | Forziati, Glasgow Jr., etc. |
| 20 | 0.79625 | „ | 25 | 0.79222 | „ (1946) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1188 | Miller (1935) |
| 30 | 925 | „ |

*Refractive index*

| t° | He r. | D | He y. | He g. | |
|---|---|---|---|---|---|
| 18.8 | 1.43387 | — | 1.43663 | 1.44548 | Miller (1935) |
| 26.4 | 1.43061 | — | 1.43343 | 1.44211 | „ |
| $\frac{dn}{dt}$ | 0.00043 | — | 0.00042 | 0.00044 | „ |
| 20 | — | 1.43596 | — | — | Forziati, Glasgow Jr., etc. (1946) |
| 25 | — | 1.43358 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00048 | — | — | „ |

*Specific heat:* Huffman, Todd and Oliver (1919) (M.W. 112.208)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. I −261.24 | 0.00778 | −131.50 | 0.21109 | C. II −260.97 | 0.01333 | −172.86 | 0.29630 |
| −252.56 | 0.02888 | −121.23 | 0.22286 | (unst.) −252.55 | 0.03645 | −164.26 | 0.29767 |
| −242.83 | 0.05319 | −119.44 | 0.22533 | −241.07 | 0.06405 | −148.06 | 0.30353 |
| −232.56 | 0.07427 | C. II − 97.68 | 0.33139 | −222.56 | 0.09661 | −139.77 | 0.30729 |
| −220.98 | 0.09401 | − 88.93 | 0.33481 | −212.73 | 0.11188 | −131.63 | 0.31094 |
| −213.20 | 0.10600 | − 70.48 | 0.34736 | −203.53 | 0.12557 | −122.40 | 0.31498 |
| −201.64 | 0.12278 | − 57.47 | 0.35675 | −195.58 | 0.13796 | −111.39 | 0.32085 |
| −190.22 | 0.13900 | L. − 44.86 | 0.38749 | −182.77 | 0.16777 | −106.60 | 0.32397 |
| −182.44 | 0.14957 | − 29.41 | 0.39896 | −179.19 | 0.23983 | | |
| −170.18 | 0.16533 | − 11.14 | 0.41453 | −178.59 | 0.30197 | | |
| −159.20 | 0.17876 | + 2.50 | 0.42643 | | | (other values, see authors) | |
| −141.88 | 0.20000 | 25.66 | 0.44857 | | | | |

| | | |
|---|---|---|
| *Heat of vaporization* | 25° 84.589 cal 15°/g | Osborne and Ginnings (1947) |
| *Heat of transition* | 16.695 „ | Huffman, Todd and Oliver (1949) |
| *Heat of melting* | 3.5042 „ | „ |

## 1,3 and 1,4-DIMETHYL-*cyclo*-HEXANES $C_6H_{10}(CH_3)_2$

**Constants:** MILLER (1935)

| | 1,3 *trans* | 1,3 *cis* | 1,4 *trans* | 1,4 *cis* | |
|---|---|---|---|---|---|
| *Boiling point* | 120·4 | 124·9 | 119·63 | 124·59 | MILLER (1935) |
| *Freezing point* | — | −75·560 | −36·92 | −87·425 | STREIFF, MURPHY, ZIMMERMAN, SEDLAK, SOULE, WILLINGHAM, and ROSSINI (1947) |
| | −90°097 | −75°567 | −36°943 | −87°427 | HUFFMAN, TODD and OLIVER (1949) |
| *Critical solution point in* $C_6H_5$–$NH_2$ | 51°7 | 46°3 | 52°7 | 46°9 | MILLER (1935) |
| *Density* 0° | 0.78251 | 0.80022 | 0.77913 | 0.79925 | ,, |
| 20° | 0.76628 | 0.78348 | 0.76264 | 0.78271 | ,, |
| *Viscosity* $\eta \cdot 10^5$ 15° | 665 | 888 | 749 | 933 | ,, |
| 30° | 556 | 722 | 614 | 749 | ,, |

*Refractive index*

| | 1,3 *trans* | | 1,3 *cis* | | 1,4 *trans* | | 1,4 *cis* | |
|---|---|---|---|---|---|---|---|---|
| | 18°8 | 26°4 | 18°8 | 26°4 | 18°8 | 26°4 | 18°8 | 26°4 |
| He r. | 1.42099 | 1.41772 | 1.42835 | 1.42495 | 1.41887 | 1.41556 | 1.42755 | 1.42425 |
| He y. | 1.42376 | 1.42047 | 1.43099 | 1.42765 | 1.42160 | 1.41827 | 1.43029 | 1.42700 |
| He g. | 1.43254 | 1.42919 | 1.43972 | 1.43645 | 1.43033 | 1.42697 | 1.43917 | 1.43568 |

**Heat Constants:** HUFFMAN, TODD and OLIVER (1949)

*Specific heat:* (M.W. 112.208)

| 1,3 *trans* | | 1,3 *cis* | | 1,4 *trans* | | 1,4 *cis* | |
|---|---|---|---|---|---|---|---|
| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
| C. −260.75 | 0.009866 | C. −259.98 | 0.01111 | C. −259.20 | 0.01146 | C. −260.87 | 0.00839 |
| −253.70 | 0.03558 | −254.23 | 0.02604 | −252.77 | 0.02698 | −253.99 | 0.02527 |
| −242.72 | 0.03683 | −243.30 | 0.05447 | −242.86 | 0.05164 | −241.05 | 0.05871 |
| −232.43 | 0.07578 | −233.30 | 0.07510 | −230.77 | 0.07649 | −230.57 | 0.07971 |
| −213.88 | 0.10602 | −221.23 | 0.095269 | −212.12 | 0.10695 | 219.37 | 0.098620 |
| −204.84 | 0.11962 | −211.79 | 0.10966 | −197.67 | 0.12831 | −212.17 | 0.10955 |
| −191.21 | 0.13904 | −198.15 | 0.12921 | −182.48 | 0.15037 | −192.92 | 0.13653 |
| −181.75 | 0.15190 | −190.78 | 0.13969 | −170.17 | 0.16632 | −180.62 | 0.15341 |
| −167.80 | 0.16994 | −183.07 | 0.15019 | −162.78 | 0.17614 | −172.50 | 0.16345 |
| −159.68 | 0.18015 | −172.02 | 0.16454 | −153.53 | 0.18839 | −161.99 | 0.17674 |
| −143.67 | 0.19985 | −164.62 | 0.17508 | −138.13 | 0.20775 | −153.79 | 0.18679 |
| −127.41 | 0.21972 | −137.33 | 0.20777 | −130.72 | 0.21708 | −128.54 | 0.21677 |
| 120.54 | 0.22817 | −121.31 | 0.22646 | −122.34 | 0.22758 | −110.44 | 0.23635 |
| −112.36 | 0.23838 | −110.48 | 0.24176 | − 97.39 | 0.26129 | L. − 83.67 | 0.37130 |
| −106.12 | 0.24533 | −101.95 | 0.25216 | − 72.39 | 0.30806 | − 67.01 | 0.37949 |

*Specific heat:* (M.W. 112.208) (continued)

| 1,3 *trans* | | 1,3 *cis* | | 1,4 *trans* | | 1,4 *cis* | |
|---|---|---|---|---|---|---|---|
| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
| L.−82.40 | 0.36771 | L.− 68.97 | 0.36577 | − 52.55 | 0.38371 | − 58.50 | 0.38445 |
| −70.30 | 0.37518 | − 52.49 | 0.37677 | L.− 28.39 | 0.40069 | − 49.24 | 0.39019 |
| −61.55 | 0.38085 | − 22.35 | 0.40107 | − 11.07 | 0.41442 | − 38.88 | 0.39674 |
| −42.51 | 0.39381 | − 0.32 | 0.42076 | + 17.05 | 0.43999 | − 24.84 | 0.40728 |
| −22.52 | 0.40931 | + 17.77 | 0.43908 | 26.09 | 0.44908 | + 4.09 | 0.43204 |
| − 3.15 | 0.42653 | 26.32 | 0.44700 | | | 30.06 | 0.45695 |
| + 7.06 | 0.43544 | | | (other values, see authors) | | | |
| 25.98 | 0.45427 | | | | | | |

*Heat of melting* cal 15°/g

| 21.014 | 23.047 | 26.265 | 19.823 |
|---|---|---|---|

## *Cyclo*-HEXENE $C_6H_{10}$

Prepared by dehydration of *cyclo*-hexanol

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 82°75 | Lecat (passim) | 83°1 | Allsopp (1934) |
| 82°8 | Parks and Huffman (1930) | 83°2 | Harrison and Berg (1946) |
| 82°84 | Waterman and Van Westen (1929) | 83°2 | Hückel and Harder (1947) |
| 82°9 | Watson and Bircher (1949) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −103°500 | Streiff, Zimmerman, Soule, Butt, Sedlak, Willingham and Rossini (1948) | −103°7 | Timmermans (passim) |
| | | −103°9 | Seyer and King (1933) |
| | | −104°1 | Parks and Huffman (1930) |

*Triple point:* −103°49 Huffman, Eaton and Oliver (1948)

*Transition point*

| | | | |
|---|---|---|---|
| −134°4 | Parks and Huffman (1930) | −134°46 | Huffman, Eaton and Oliver (1948) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.8296 | Seyer and King (1933) | −19.0 | 0.8481 | Hückel and Harder (1947) |
| 10 | 0.8202 | ,, | +14.7 | 0.8158 | ,, |
| 20 | 0.8109 | ,, | 46.0 | 0.7855 | ,, |
| 30 | 0.8017 | ,, | 77.6 | 0.7564 | ,, (1947) |
| 40 | 0.7921 | ,, | 20 | 0.8110 | Allsopp (1934) |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 0 | 29.25 | Seyer and King (1933) | 34.0 | 33.55 | Hückel and Harder |
| 10 | 27.89 | ,, | −19.0 | 31.61 | ,, (1947) |
| 20 | 26.54 | ,, | 0.0 | 29.13 | ,, |
| 30 | 25.22 | ,, | 15.2 | 27.23 | ,, |
| 40 | 23.98 | ,, | 35.8 | 24.76 | ,, |
| | | | 56.8 | 22.23 | ,, |
| | | | 76.0 | 20.09 | ,, |
| | | | 20 | 26.6 | Smith (1944) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 14.7 | — | 1.4495 | — | — | Hückel and Harder (1947) |
| 20 | — | 1.44644 | — | — | Allsopp (1934) |
| 20 | — | 1.4467 | — | — | Harrison and Berg (1946) |
| 20.05 | 1.44360 | 1.44637 | 1.45312 | 1.45874 | Waterman and Van Westen (1929) |
| 25 | — | 1.4437 | — | — | Watson and Bircher (1949) |

**Heat constants**

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|
| C. I | −258.29 | 0.00961 | L. −94.17 | 0.34225 | Huffman, Eaton and Oliver (1948) |
| | −251.98 | 0.0252 | −79.22 | 0.35010 | (M.W. 82.14) |
| | −240.17 | 0.05977 | −71.08 | 0.35479 | ,, (Values at other |
| | −228.34 | 0.08866 | −62.38 | 0.36018 | ,, temperatures: see |
| | −217.24 | 0.1096 | −52.86 | 0.36650 | ,, authors) |
| | −210.19 | 0.1210 | −43.04 | 0.37373 | ,, |
| | −201.79 | 0.13242 | −32.51 | 0.38215 | ,, |
| | −189.04 | 0.14870 | −21.73 | 0.39101 | ,, |
| | −180.86 | 0.15804 | −19.28 | 0.39302 | ,, |
| | −169.52 | 0.16980 | −11.19 | 0.39998 | ,, |
| | −161.75 | 0.17817 | − 0.86 | 0.40934 | ,, |
| | −139.06 | 0.20489 | + 0.45 | 0.41047 | ,, |
| C. II | −125.01 | 0.28632 | 10.44 | 0.41979 | ,, |
| | −120.78 | 0.29020 | 19.43 | 0.42858 | ,, |
| | −111.63 | 0.30393 | 27.45 | 0.43640 | ,, |

| | | |
|---|---|---|
| *Heat of transition* | 11.86 cal 15°/g | Parks and Huffman (1930) |
| | 12.367 ,, | Huffman, Eaton and Oliver (1948) |
| *Heat of melting* | 9.57 ,, | Parks and Huffman (1930) |
| | 9.582 ,, | Huffman, Eaton and Oliver (1948) |

Pure METHYL-*cyclo*-HEXENE has never been studied carefully.

## 1,4-DIMETHYL-*cyclo*-HEXENE $C_6H_8(CH_3)_2$

**Constants:** Chiurdoglu (1938)

*Boiling point:* 128°7

*Freezing point:* −59°4 Timmermans (passim)

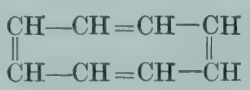
*Density* *Viscosity* *Refractive index*

| t° | d | t° | $\eta \cdot 10^5$ | t° | Hα | D | Hβ | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 0.80472 | 15 | 695 | 20 | 1.44300 | 1.44586 | 1.45242 | 1.45805 |
| 20 | 0.80061 | 30 | 579 | | | | | |
| 30 | 0.79240 | | | | | | | |

## *Cyclo*-HEXADIENE 1,3 $C_6H_8$

*Boiling point, density* and *refractive index* Allsopp (1934)

## *Cyclo*-OCTATETRAENE



**Constants:** Scott, Gross, Oliver and Huffman (1949)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 0 | 1.51 | 35 | 13.72 | 60 | 46.79 |
| 15 | 4.29 | 40 | 17.91 | 65 | 58.20 |
| 20 | 5.84 | 45 | 23.06 | 70 | 71.89 |
| 25 | 7.84 | 50 | 29.45 | 75 | 88.13 |
| 30 | 10.43 | 55 | 37.26 | | |

*Melting point:* −4°682 *Triple point:* −4°68

*Specific heat:* (M.W. 104.144)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −260.36 | 0.009813 | −181.21 | 0.14197 | −22.22 | 0.30602 | (Values at other temperatures: see authors) |
| −253.88 | 0.02663 | −165.98 | 0.15736 | − 7.02 | 0.39937 | |
| −242.61 | 0.05602 | −147.50 | 0.17568 | L. − 0.19 | 0.41101 | |
| −234.64 | 0.07241 | −117.66 | 0.20428 | +14.41 | 0.41888 | |
| −218.70 | 0.09700 | − 77.55 | 0.24404 | 32.97 | 0.42959 | |
| −212.28 | 0.10555 | − 48.19 | 0.27534 | 52.20 | 0.44101 | |
| −200.10 | 0.12039 | | | | | |

| | |
|---|---|
| *Heat of vaporisation* | 98.901 cal 15°/g |
| *Heat of melting* | 25.873 „ |

## TETRALIN or 1.2.3.4-TETRAHYDRONAPHTHALENE $C_{10}H_{12}$

**Constants**

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 93.8 | 20 | Herz and Schuftan (1922) | 150.0 | 162 | Herz and Schuftan (1922) |
| 103.0 | 30 | „ | 167.5 | 273 | „ |
| 140.0 | 118 | „ | 206.2 | 740 | „ |

*Boiling point*

| | |
|---|---|
| 207°3 | Herz and Schuftan (1922) |
| 207°57 | Mair and Streiff (1941) |

*Melting point*

| | |
|---|---|
| −35°0 | Herz and Schuftan (1922) |
| −35°80 | Mair and Streiff (1941) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0.2 | 0.9842 | Herz and Schuftan (1922) | 24.7 | 0.9658 | Herz and Schuftan (1922) |
| 13.5 | 0.9743 | „ | 84.0 | 0.9210 | „ |
| 15.1 | 0.9731 | „ | 150.0 | 0.8718 | „ |
| | | | 25 | 0.9662 | Mair and Streiff (1941) |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | t° | $\gamma$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 25 | 2003 | 13.3 | 36.20 | 78.45 | 29.26 | Herz and Schuftan (1922) |
| 50 | 1302 | 36.7 | 33.62 | 179.6 | 18.83 | „ |
| 75 | 906.6 | 60.0 | 31.13 | | | „ |

*Refractive index*

| t° | Hα | D | Hβ | |
|---|---|---|---|---|
| 25 | 1.53466 | 1.53919 | 1.55065 | Mair and Streiff (1941) |

| | 5-METHYL-1,2,3,4-TETRAHYDRO-NAPHTHALENE $C_{10}H_{11}-CH_3$ | 6-METHYL-1,2,3,4-TETRAHYDRO-NAPHTHALENE $C_{10}H_{11}-CH_3$ |
|---|---|---|
| **Constants:** Mair and Streiff (1941) | | |
| *Boiling point* | 234°35 | 229°03 |
| *Melting point* | −22°90 | −39°75 |
| *Density* 25° | 0.9682 | 0.9500 |
| *Refractive index* 25° | | |
| Hα | 1.53738 | 1.52920 |
| D | 1.54190 | 1.53365 |
| Hβ | 1.55325 | 1.54498 |

## DECALIN or DECAHYDRONAPHTHALENE *cis* and *trans* $C_{10}H_{18}$

### Constants

*Saturated vapour pressure:* Seyer and Mann (1945)

| *Cis* | | | | *Trans* | | | |
|---|---|---|---|---|---|---|---|
| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
| −30.0 | 0.44 | 83.5 | 38.18 | −29.5 | 0.38 | 60.0 | 8.24 |
| −24.1 | 0.60 | 95.5 | 55.01 | −19.2 | 0.65 | 70.0 | 12.57 |
| −11.1 | 1.07 | 112.4 | 95.11 | −10.0 | 0.86 | 80.1 | 19.50 |
| − 0.7 | 1.73 | 119.4 | 121.10 | 0.0 | 1.09 | 92.4 | 32.81 |
| 0.0 | 1.82 | 136.7 | 206.85 | 12.0 | 1.48 | 105.1 | 54.50 |
| 13.0 | 2.87 | 152.3 | 320.65 | 20.0 | 1.82 | 109.8 | 63.15 |
| 30.9 | 6.03 | 168.0 | 489.49 | 38.0 | 3.44 | 112.4 | 68.66 |
| 38.9 | 8.23 | 187.1 | 776.05 | 43.4 | 4.00 | 124.6 | 105.21 |
| 51.5 | 12.02 | 208.8 | 1280.02 | 49.9 | 5.30 | 148.7 | 225.82 |
| 59.7 | 16.72 | 212.9 | 1396.4 | 50.4 | 5.41 | 172.7 | 434.28 |
| 65.3 | 20.00 | 223.4 | 1722.3 | 52.9 | 6.06 | 194.7 | 761.02 |
| 74.4 | 27.02 | 235.3 | 2145.3 | 56.9 | 7.31 | | |

*Melting point*

| *Cis* | *Trans* | |
|---|---|---|
| −43°26 | −31°47 | Seyer and Davenport (1941) |

*Density* and *surface tension*

| *Cis* | | | *Trans* | | | |
|---|---|---|---|---|---|---|
| t° | d | $\gamma$ | t° | d | $\gamma$ | |
| 0 | 0.9120 | 34.50 | 0 | 0.8849 | 31.91 | Seyer and Davenport |
| 10 | 0.9044 | 33.36 | 10 | 0.8775 | 30.87 | „ (1941) |
| 20 | 0.8967 | 32.18 | 20 | 0.8700 | 29.89 | „ (Values at other tem- |
| 30 | 0.8892 | 31.01 | 30 | 0.8627 | 28.87 | „ peratures, see authors) |

*Viscosity*

| *Cis* | | *Trans* | | |
|---|---|---|---|---|
| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
| 00.00 | 5620 | 00.00 | 3233 | Seyer and Leslie (1942) |
| 10.00 | 4300 | 10.00 | 2588 | „ |
| 20.00 | 3381 | 20.00 | 2128 | „ (Values at other tempe- |
| 30.00 | 2723 | 30.00 | 1774 | „ ratures: see authors) |

In a recent publication, Parks and Hatton (1949) give the heat constants of the same compounds with samples, melting respectively at −43°06 and −30°76, but they consider these both samples as not very pure since they contain, the first 0.4 mole % impurity and the second, 1.1 mole % impurity.

## α-PINENE and β-PINENE $C_{10}H_{16}$

*Boiling point, density, refractive index* and *rotatory power* Fuguitt, Stallcup and Hawkins (1942)

*Natural and magnetic rotatory power* Rabinovitch (1940)

## 2. HALOGENATED DERIVATIVES

The monohalogenated derivatives of the paraffins are generally obtained by the action of the hydracid on the corresponding alcohol in presence of sulphuric acid as dehydrating agent; the crude products are therefore contaminated by the alcohol which has been used in the preparation and with which moreover many of them give azeotropes.

It is easy to eliminate these alcohols by washing followed by distillation on a water bath over $P_2O_5$, but on progressing in the series, particularly with secondary and tertiary compounds, the low stability of the halogenated derivative, especially if it contains bromine or iodine, may lead to partial decomposition of the product with formation of hydracid and an ethylenic hydrocarbon.

For iodides, the following method of purification can be recommended: the alcohol is caused to react with iodine in presence of red phosphorus; the iodine, dried over sodium sulphate, is decolorised by shaking with mercury and distilled at ordinary pressure until the density is constant for several successive fractions, even after treatment with sodium carbonate. The iodides must be kept in the dark.

### A. HALOGENATED DERIVATIVES OF METHANE

These compounds have been studied a great deal. Most of them are provided by industry.

#### METHYL FLUORIDE $CH_3F$

*Preparation:* This gas is obtained by action of a metallic fluoride on potassium methylsulphate or methyl iodide. Moles and Batuecas (1919–20).

**Constants**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −103.30 | 150.9 | −82.36 | 594.1 | −78.30 | 746.2 | Moles and Batuecas (1929) |
| − 87.80 | 429.8 | −82.43 | 592.9 | −78.20 | 757.9 | |
| − 87.50 | 439.2 | −81.57 | 628.3 | −77.70 | 774.8 | " |
| − 87.08 | 465.2 | −81.14 | 651.7 | −77.50 | 790.2 | " |
| − 85.71 | 489.1 | −80.47 | 663.9 | −75.73 | 871.7 | " |
| − 85.59 | 493.9 | −78.60 | 731.4 | | | " |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −108.887 | 98.50 | −71.699 | 1083.30 | −48.742 | 3074.66 | Michels and Wassenaar |
| −105.887 | 124.79 | −69.190 | 1229.68 | −47.387 | 3249.0 | „ (1948) |
| −101.848 | 169.56 | −66.908 | 1375.45 | −40.372 | 4262.84 | „ |
| − 98.222 | 220.17 | −64.820 | 1519.92 | −31.097 | 5953.84 | „ |
| − 93.383 | 306.20 | −62.301 | 1710.30 | −25.756 | 7127.28 | „ |
| − 87.838 | 437.23 | −58.988 | 1987.02 | −21.015 | 8309.08 | „ |
| − 85.309 | 509.96 | −56.384 | 2229.69 | −11.374 | 11155.28 | „ |
| − 82.743 | 593.03 | −54.920 | 2375.91 | − 4.350 | 13642.76 | „ |
| − 80.359 | 679.97 | −53.597 | 2514.31 | + 1.235 | 15912.12 | „ |
| − 77.321 | 804.61 | −51.926 | 2697.01 | 6.889 | 18477.88 | „ |
| − 74.120 | 964.54 | −50.334 | 2881.92 | 15.208 | 22841.80 | „ |

*Boiling point*

| | | |
|---|---|---|
| −78°14 | (interp.) | Moles and Batuecas (1920) |
| −78°414 | „ | Michels and Wassenaar (1948) |

*Weight of the normal litre:* 1.54507 g Moles and Batuecas (1920) (corr. val. 1919)

*Molecular weight of the gas:* 34.0318 Cawood and Patterson (1936)

*Deviation from Avogadro's law:* $A_0^I = 1.01771$ Moles and Batuecas (1920)

## METHYL CHLORIDE $CH_3Cl$

Survey of the thermal properties of methyl chloride: G. Holst (1913) and Tanner, Benning and Mathewson (1939). R. Pieck and Ch. Courtoy (1947) are examining the methods of preparation of this compound; they suggest the action of $PCl_5$ on methanol or, even better, direct chlorination of methane to obtain a product quite free from dimethylether.

### Constants

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 143.12 | 65.93 | 0.353 | Brinkman (1904) |
| 143.2 | 65.85 | — | Baume (1908) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −75 | 45 | −10 | 1349 | Ganeff and Jungers (1948) |
| −60 | 121 | −5 | 1622 | ,, |
| −50 | 216 | 0 | 1945 | ,, |
| −40 | 365 | +5 | 2315 | ,, |
| −30 | 588 | | | ,, |
| −20 | 907 | | | ,, |
| −25 | 729 | — | — | Kamerlingh Onnes and Zakrzewsky (1904) |

| t° | p atm. | p mm | |
|---|---|---|---|
| −47.20 | 0.3173 | or 241.15 | Holst (1913–1914) |
| −39.28 | 0.4869 | 370.04 | ,, |
| −30.26 | 0.7467 | 567.49 | ,, |
| −14.39 | 1.4941 | 1135.52 | ,, |
| − 4.65 | 2.1536 | 1636.74 | ,, |
| +10.58 | 3.658 | | ,, |
| 16.20 | 4.369 | | ,, |
| 20.58 | 4.992 | | ,, |
| 26.96 | 5.974 | | ,, |
| 32.77 | 7.072 | | ,, |
| 33.18 | 7.118 | | ,, |
| 39.70 | 8.625 | | ,, |
| 100.02 | 31.44 | | Brinkman (1904) |
| 114.96 | 41.17 | | ,, |
| 130.82 | 53.15 | | ,, |

*Boiling point:* −24°09 Gibbs (1905)

*Freezing point:* −97°20 Glasgow Jr., Krouskop, Beadle, Axilerod and Rossini (1948)

*Weight of the normal litre:* 2.3075 g Batuecas (1926)

*Deviation from Avogadro's law:* $A_0^I$ 1.0244 Batuecas (1926)

*Compressibility of the gas:* at 15° Leduc (1898–1909); at 20°6 Holst (1913–1914)

## METHYL BROMIDE $CH_3Br$

**Constants:** Egan and Kemp (1938)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −69.974 | 12.98 | −30.062 | 167.39 | −8.140 | 472.50 |
| −61.915 | 23.83 | −22.527 | 244.67 | −2.279 | 601.78 |
| −52.913 | 44.18 | −15.152 | 346.44 | +1.072 | 690.97 |
| −44.326 | 75.34 | −15.144 | 346.64 | +4.522 | 790.56 |
| −36.676 | 117.09 | | | | |

| *Boiling point* | *Melting point* | *Transition point* |
|---|---|---|
| + 3.457 | −93.72 | −99°41 |

*Weight of the litre:* at 25° and 1 atm. 3.9739 g

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. I −258.54 | 0.01529 | −166.44 | 0.1287 | L. −88.70 | 0.1963 |
| −255.67 | 0.02155 | −160.18 | 0.1311 | −83.08 | 0.1962 |
| −251.77 | 0.03028 | −153.99 | 0.1332 | −76.62 | 0.1951 |
| −247.71 | 0.03907 | −147.70 | 0.1348 | −70.24 | 0.1948 |
| −244.00 | 0.04629 | −141.24 | 0.1371 | −57.11 | 0.1947 |
| −239.63 | 0.05495 | −135.10 | 0.1392 | −38.42 | 0.1945 |
| −234.89 | 0.06500 | −129.15 | 0.1403 | −26.09 | 0.1952 |
| −228.98 | 0.07423 | −122.93 | 0.1418 | −20.30 | 0.1962 |
| −223.37 | 0.08217 | −116.71 | 0.1432 | −14.69 | 0.1964 |
| −217.97 | 0.09062 | −110.76 | 0.1442 | − 8.91 | 0.1969 |
| −212.03 | 0.09774 | −107.89 | 0.1451 | − 2.91 | 0.1977 |
| −206.29 | 0.1028 | −104.95 | 0.1470 | + 2.43 | 0.1978 |
| −200.95 | 0.1072 | C. II − 97.95 | 0.1623 | | |
| −193.62 | 0.1119 | − 96.75 | 0.1639 | | |
| −190.05 | 0.1158 | − 96.68 | 0.1650 | | |
| −184.56 | 0.1197 | − 96.28 | 0.1652 | | |
| −178.63 | 0.1227 | − 95.40 | 0.1729 | | |
| −172.61 | 0.1259 | | | | |

| *Heat of vaporisation* | *Heat of melting* | *Heat of transition* |
|---|---|---|
| 60.2275 cal 15°/g | 15.0542 cal 15°/g | 1.1946 cal 15°/g |

## METHYL IODIDE $CH_3I$

Gives an azeotropic mixture with 8 % of methyl alcohol, boiling at 39°6 (HOLLEY, 1902).

**Constants:** B.E. (1934)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 0.1 | 142 | THOMPSON and LINNETT (1936) | 11.7 | 235 | THOMPSON and LINNETT (1936) |
| 4.3 | 171 | „ | 34.4 | 569 | „ |

*Boiling point:* 42°50 $\frac{dt}{dp}$ *(10 mm):* 0°36 B.E. (1934) and LECAT (passim)

*Freezing point:* −66°45

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 2.33504 | B.E. (1934) | 30 | 2.25102 | B.E. (1934) |
| 15 | 2.29300 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 518 | B.E. (1934) |
| 30 | 460 | „ |
| 0 | 594 | LINEBARGER (1896) |
| 0 | 593 | SACHANOV and RJAKOWSKY (1914) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 30.92 | B.E. (1934) |
| 20 | 30.14 | „ |
| 30 | 28.61 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.52836 | 1.52900 | 1.53444 | 1.54497 | 1.54733 | 1.55537 |
| $\frac{dn}{dt}$ | 0.00065 | 65 | 65 | 66 | 66 | 67 |

# METHYLENE DICHLORIDE $CH_2Cl_2$

**Constants:** B.E. (1932)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −40 | 15 | 10 | 229 | Ganeff and Jungers (1948) |
| −30 | 28 | 15 | 284 | „ |
| −20 | 51 | 20 | 350 | „ |
| −10 | 88 | 25 | 429 | „ |
| − 5 | 114 | 30 | 523 | „ |
| 0 | 145 | 35 | 630 | „ |
| +5 | 183 | 40 | 755 | „ |

*Boiling point*

| | |
|---|---|
| 39°95 | $\frac{dt}{d_p}$ *(10 mm)* 0°43 B.E. (1932) |
| 40°0 | „ 0°42 Lecat (passim) |
| 40°21 | Ganeff and Jungers (1948) |

*Freezing point*

| | |
|---|---|
| −96°5 | Hrynakowski and Szmyt (1938) |
| −96°8 | B.E. (1932) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.36174 | B.E. (1932) | 30 | 1.30777 | B.E. (1932) |
| 15 | 1.33479 | „ | 20 | 1.3255 | Eftring (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 449 | B.E. (1932) |
| 30 | 393 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 28.83 | B.E. (1932) |
| 20 | 28.12 | „ |
| 30 | 26.54 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.42433 | 1.42466 | 1.42721 | 1.43186 | 1.43297 | 1.43694 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 55 | 55 | 55 | 57 | „ |
| 20 | — | — | 1.4244 | — | — | — | Eftring (1938) |

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| L. −58.0 | 0.2767 | −29.0 | 0.2741 | − 0.5 | 0.2788 | Perlick (1937) |
| −53.8 | 0.2762 | −23.7 | 0.2741 | + 7.9 | 0.2812 | „ |
| −46.0 | 0.2750 | −19.0 | 0.2744 | 13.7 | 0.2832 | „ |
| | | | | 19.3 | 0.2838 | „ |

*Heat of combustion:* 20° ($c_v$) 1690.8 cal 15°/g Eftring (1938)

## METHYLENE DIBROMIDE $CH_2Br_2$

**Constants:** B.E. (1932)

*Boiling point*

| | | |
|---|---|---|
| 96°95 | $\frac{dt}{dp}$ *(10 mm)* | 0°42 |
| 97°0 | „ | 0°42 Lecat (passim) |

*Freezing point*

−52°7

*Density*

| t° | d | |
|---|---|---|
| 0 | 2.54852 | B.E. (1932) |
| 15 | 2.50986 | „ |
| 30 | 2.47133 | |

*Viscosity*

| t° | $\eta \cdot 10^4$ | |
|---|---|---|
| 15 | 108.9 | B.E. (1932) |
| 30 | 91.6 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.53950 | 1.54012 | 1.54463 | 1.55299 | 1.55562 | 1.56163 |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 54 | 55 | 55 | 57 |

## METHYLENE DIIODIDE $CH_2I_2$

This compound decomposes at the boiling point.

**Constants:** B.E. (1932)

*Freezing point:* 6°10 (stable form)
5°60 (metastable form)

*Melting curve:* DEFFET (1935) *Transition curve:* DEFFET (1935)

| *Form I* | | *Form II* | | *Form III* | | *II → III* | | | |
|---|---|---|---|---|---|---|---|---|---|
| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
| 6.10 | 1 | 5.60 | 1 | 14.00 | 454 | −6.5 | 1 | 8.35 | 330 |
| 7.90 | 108 | 9.00 | 190 | 15.00 | 506 | −0.2 | 143 | 10.80 | 382 |
| 8.30 | 130 | 10.80 | 282 | 16.90 | 596 | +2.30 | 200 | 12.90 | 430 |
| 9.60 | 202 | 11.90 | 340 | 18.40 | 690 | 6.80 | 300 | | |
| 10.00 | 220 | 13.00 | 412 | 20.30 | 786 | | | | |
| 12.30 | 348 | 14.00 | 454 | 22.50 | 900 | | | | |
| 13.20 | 390 | | | | | | | | |
| 14.80 | 478 | | | | | | | | |
| 17.50 | 620 | | | | | | | | |
| 18.50 | 670 | | | | | | | | |
| 20.00 | 752 | | | | | | | | |
| 24.00 | 954 | | | | | | | | |
| 25.00 | 1020 | | | | | | | | |

*Density*

| t° | d | |
|---|---|---|
| 15 | 3.3345 | B.E. (1932) |
| 20 | 3.3212 | ,, |
| 30 | 3.2944 | ,, |

*Viscosity*

| t° | $\eta \cdot 10^4$ | |
|---|---|---|
| 15 | 304.3 | B.E. (1932) |
| 30 | 239.2 | ,, |

*Refractive index*

| t° | Hα | D | He y. | Hβ |
|---|---|---|---|---|
| 15 | 1.73403 | 1.74428 | 1.74461 | 1.77161 |
| $\frac{dn}{dt}$ | 0.00061 | — | 64 | 67 |

## TRICHLOROMETHANE or CHLOROFORM $CHCl_3$

*Purification:* B.E. (1926)

Very pure chloroform is unstable in the presence of air; it tends to oxidise with formation of phosgene and hydrochloric acid (Clover, 1923; Allport, 1931). Determination of the impurities and study of the stability of chloroform (Gillo, 1938). Ionisable chlorine is determined in the form of silver chloride by nephelometry or by titration.

Gillo (1938) showed that it is hardly possible to reduce the concentration of $COCl_2$ below $3 \cdot 10^{-4}$ %, which appears to indicate that the chloroform decomposes even during its purification. It is easy to obtain the fifth degree of purity ($\Delta t = 0°000$) as shown by the ebulliometer of Swietoslawski.

The pharmaceutical product contains about 1 % of ethyl alcohol which acts as stabiliser; it is hardly possible to remove this impurity by distillation since there is an azeotropic mixture which contains 7 % of alcohol and boils only 1°5 lower than pure chloroform (Wade and Finnemore, 1904). It is therefore necessary to eliminate the alcohol by distillation with phosphoric anhydride; the danger of this operation, especially if carried out in presence of air, lies in the liberation of traces of hydrochloric acid, which can only be eliminated by treatment with sodium carbonate (Timmermans, 1910). These conditions make the preparation and especially the conservation of pure chloroform a somewhat difficult matter; it keeps best in sealed tubes, protected from the air and in the dark.

Alcohol lowers the density and hydrochloric acid raises it; the density is an excellent criterion of purity.

**Constants**: B.E. (1926). — **Polyphasic equilibria**

*Critical constants.* Chloroform decomposes at the critical temperature.

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −62.1 | 1.0 | −42.0 | 4.5 | Stock and Stieber (1923) |
| −57.1 | 1.5 | −11.8 | 39 | „ |
| −51.5 | 2.0 | 0 | 62 | „ |
| −46.6 | 3.0 | | | „ |
| 0 | 61.0 | 20 | 158.4 | Rex (1906) |
| 10 | 100.0 | 30 | 240.0 | „ |
| 0 | 60.9 | 20 | 157.6 | Winkler (1906) |
| 10 | 99.1 | 30 | 240.7 | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 0 | 60.17 | 15 | 125.75 | Radulescu and Alexa (1938) |
| 5 | 77.47 | 20 | 157.64 | ,, |
| 10 | 99.46 | 22 | 172.13 | ,, |
| 18 | 146 | 51 | 541 | Beckmann and Liesche (1914) |
| 30 | 239 | 60 | 731 | ,, |
| 35 | 295.11 | 50 | 519.18 | Scatchard and Raymond (1938) |
| 40 | 360.20 | 55 | 617.84 | ,, |
| 45 | 433.54 | 60 | 730.13 | ,, |
| 39.620 | 355.1 | 72.118 | 1074.6 | Zmaczynski (1930) |
| 44.950 | 433.6 | 77.669 | 1268.1 | ,, |
| 50.361 | 525.76 | 83.246 | 1489.2 | ,, |
| 55.716 | 633.90 | 88.857 | 1741.0 | ,, |
| 61.152 | 760.00 | 94.504 | 2026.3 | ,, |
| 66.622 | 906.1 | 100.186 | 2374.4 | ,, |
| 33.25 | 276 | | | Kohnstamm and Van Dalfsen (1901–1902) |

*Boiling point*

| | | | |
|---|---|---|---|
| 61°152 | Zmaczynski (1930) | 61°2 | Eftring (1938) |
| 61°16 | Wade and Finnemore (1904) | 61°2 | Lecat (passim) |
| 61°17 | Stull (1937) | 61°2 | Beckmann and Liesche (1914) |
| 61°20 | B.E. (1926) | 61°27 | Van der Werf, Davidson and Michaelis (1948) |
| 61°2 | Young (1910) | | |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°37 | Lecat (passim) | 0°403 | Zmaczynski (1930) |
| 0°38 | B.E. (1926) | 0°41 | Beckmann and Liesche (1914) |
| 0°39 | Regnault (1862) | | |

*Melting point*

| | | | |
|---|---|---|---|
| −63°49 | Stull (1937) | −63°5 | Timmermans, Van der Horst and Kamerlingh Onnes (1922) and B.E. (1926) |

## Constants of state

*Density*

| t° | d | t° | d | |
|---|---|---|---|---|
| −63.3 | 1.64312 | −22.95 | 1.56888 | Timmermans (1912) |
| −53.6 | 1.62580 | −13.1 | 1.55071 | „ |
| −45.0 | 1.60987 | − 6.2 | 1.53811 | „ |
| −37.2 | 1.59511 | 0.0 | 1.52637 | „ |
| −35.3 | 1.59217 | 15.0 | 1.49849 | „ |
| −30.6 | 1.58325 | | | „ |

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.52638 | B.E. (1926) | 0 | 1.52649 | Tyrer (1914) |
| 15 | 1.49845 | „ | 20 | 1.4890 | Gorke, Köppe and Staiger (1908) |
| 30 | 1.47060 | „ | | | |
| 0 | 1.52649 | Young (1910) | 20 | 1.48913 | Zmaczynski (1930) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 596 | B.E. (1926) | 9.50 | 637 | Kolossowski (1925) |
| 30 | 514 | „ | 15.4 | 599 | „ |
| 20 | 568 | Gartenmeister (1890) | 16.30 | 592 | „ |
| | | | 22.8 | 555 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 28.6 | Hennaut-Roland and | 25 | 26.5 | Hannan and Marklam (1949) |
| 20 | 27.28 | Lek (1931) (corr. Lek | | | |
| 30 | 25.89 | „ (1930) | 25 | 26.67 | Cupples (1946) |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ | |
|---|---|---|---|---|---|---|
| 15 | 1.44586 | 1.44858 | 1.44865 | 1.45490 | 1.46015 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00058 | 59 | 59 | 61 | 62 | „ |
| 20 | 1.4431 | 1.4455 | — | 1.4517 | 1.4571 | Gorke, Köppe and Staiger (1908) |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 0 | 5.189 | Ball (1930) | −20 | 5.512 | Le Fevre (1938) |
| 11.2 | 4.971 | „ | −10 | 5.400 | „ |
| 18.0 | 4.848 | „ | +10 | 4.999 | „ |
| 25.0 | 4.724 | „ | 20 | 4.813 | „ |
| 30.0 | 4.636 | „ | | | |
| 40.0 | 4.473 | „ | | | |
| 50.0 | 4.310 | „ | | | |

**Heat constants**

*Specific heat*

| t° | $c_p$ | | t° | $c_p$ | |
|---|---|---|---|---|---|
| 22.40 | 0.230 | Tréhin (1921) | 39.22 | 0.232 | Tréhin (1921) |
| 30.52 | 0.231 | „ | 43.57 | 0.237 | „ |
| 34.48 | 0.233 | „ | 48.64 | 0.237 | „ |

| | | |
|---|---|---|
| *Heat of vaporisation* | 20° 66.7 cal 15°/g | Swietoslawski and Bartoszewicz (1931) |
| *Heat of combustion* | 20° ($c_v$) 935 „ | Eftring (1938) |

## TRIBROMOMETHANE or BROMOFORM $CHBr_3$

**Constants:** B.E. (1926)

*Boiling point*

| | | | |
|---|---|---|---|
| 149°18 | Van der Werf, Davidson and Michaelis (1948) | 149°55 | $\frac{dt}{dp}$ *(10 mm)* 0°49 B.E. (1926) |
| 149°5 | $\frac{dt}{dp}$ *(10 mm)* 0°49 Lecat (passim) | | „ 0°50 Paul and Schantz (1919) |

*Freezing point*

| | |
|---|---|
| 8°05 | B.E. (1926) |
| 8°3 | Van der Werf, Davidson and Michaelis (1948) |

*Density*

| t° | d | |
|---|---|---|
| 15 | 2.90350 | B.E. (1926) |
| 30 | 2.86460 | „ |
| 20 | 2.8905 | Desreux (1935) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2152 | B.E. (1926) |
| 30 | 1741 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 31.68 | Desreux (1935) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.59472 | 1.59530 | 1.60053 | 1.60088 | 1.61133 | 1.61345 | 1.62437 |
| $\frac{dn}{dt}$ | 0.00056 | 56 | 57 | 57 | 57 | 57 | 57 |

## TRIIODOMETHANE or IODOFORM $CHI_3$

Van de Vloed (1939) studied this substance very carefully with respect to purification and freezing point.

## MONOFLUORODICHLOROMETHANE $CHFCl_2$

**Constants:** Benning and Mac Harness (1939)

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 178.5 | 51.0 | 0.522 | |

*Isotherms:* Benning and Mac Harness (1940)

*Boiling point:* 8°9

*Freezing point:* −135°

*Viscosity:* 0° $412 \cdot 10^{-5}$ Lacher, Walden and Park (1949)

## DIFLUOROMONOCHLOROMETHANE $CHF_2Cl$

**Constants:** *Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 96°4 | 48.48 | Booth and Swinehart (1935) |
| 96°0 | 48.7 | Benning and Mac Harness (1939) |

*Saturated vapour pressure, rectilinear diameter and isotherms:* see Benning and Mac Harness (1939-40)

*Boiling point:* −40°8 Benning and Mac Harness (1939)

*Freezing point:* −160° „

*Specific heat:* see Benning and Mac Harness (1939)

## DICHLOROMONOBROMOMETHANE $CHCl_2Br$

The same care must be taken during purification as in the case of chloroform, as the substance is very unstable.

**Constants:** B.E. (1926)

*Boiling point:* 90°10 $\frac{dt}{dp}$ *(10 mm)* 0°53

*Freezing point:* −56°9

*Density*

| t° | d | |
|---|---|---|
| 0 | 2.0385 | B.E. (1926) |
| 15 | 2.0055 | „ |
| 30 | 1.9724 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1844 | B.E. (1926) |
| 30 | 1456 | „ |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ |
|---|---|---|---|---|---|
| 15 | 1.49773 | 1.50120 | 1.50136 | 1.50952 | 1.51633 |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 55 | 55 | 55 |

## TETRAFLUOROMETHANE or CARBON TETRAFLUORIDE $CF_4$

*Saturated vapour pressure*

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| S. | −193.1 | 0.1 | −168.29 | 12.2 | −133.19 | 517.3 | Menzel and Mohry |
| | −186.8 | 0.45 | −167.76 | 13.3 | −129.69 | 672.4 | „ (1933) |
| L. | −180.65 | 1.5 | −165.73 | 17.6 | −128.29 | 744.9 | „ |
| | −178.79 | 2.2 | −163.90 | 22.5 | −127.98 | 761.4 | „ |
| | −176.72 | 3.1 | −163.59 | 23.5 | −127.77 | 772.4 | „ |
| | −173.68 | 5.2 | −163.29 | 24.5 | −127.76 | 773.1 | „ |
| | −170.90 | 8.2 | −138.69 | 331.7 | −127.29 | 798.9 | „ |

*Molecular weight of the gas:* 87.989 Cawood and Patterson (1936)
*Boiling point:* −128°0 Menzel and Mohry (1933)
*Triple point:* −183°6 „

## TETRACHLOROMETHANE or CARBON TETRACHLORIDE $CCl_4$

*Purification:* by fractional distillation. Some authors subject the product to chemical treatment in order to eliminate sulphur compounds, but this is unnecessary when starting from a good commercial sample. The criteria of purity used at the B.E. are the constancy of boiling point and density. Young used also as a criterion of purity the constancy of the saturated vapour tension during the whole isothermal liquefaction.

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 283.15 | 34181 | 0.5576 | Young (1900–1910) |
| 283.2 | — | — | Fischer and Reichel (1943) |

*Densities of the liquid and the saturated vapour:* Young (1910)

| t° | d. liq. | d. vap. | t° | d. liq. | d. vap. |
|---|---|---|---|---|---|
| 50 | 1.53611 | — | 180 | 1.2470 | 0.05249 |
| 60 | 1.5163 | — | 190 | 1.2192 | 0.06250 |
| 70 | 1.4963 | 0.004570 | 200 | 1.1888 | 0.07418 |
| 80 | 1.4765 | 0.006083 | 210 | 1.1566 | 0.08787 |
| 90 | 1.4554 | 0.007955 | 220 | 1.1227 | 0.1040 |
| 100 | 1.4343 | 0.01027 | 230 | 1.0857 | 0.1232 |
| 110 | 1.4124 | 0.01307 | 240 | 1.0444 | 0.1464 |
| 120 | 1.3902 | 0.01639 | 250 | 0.9980 | 0.1754 |
| 130 | 1.3680 | 0.02037 | 260 | 0.9409 | 0.2146 |
| 140 | 1.3450 | 0.03040 | 270 | 0.8666 | 0.2710 |
| 160 | 1.2982 | 0.03650 | 280 | 0.7634 | 0.3597 |
| 170 | 1.2734 | 0.04367 | | | |

*Rectilinear diameter:* $0.8165 - 9564 \cdot 10^{-7}\, t° + 1480 \cdot 10^{-10}\, t^{°2}$ Young (1900)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −50.1 | 0.925 | −59.6 | 0.384 | Mündel (1913) |
| −54.8 | 0.595 | −65.3 | 0.224 | „ |
| −56.8 | 0.504 | −69.7 | 0.145 | „ |
| −58.8 | 0.410 | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −21.4 | 9.10 | −10.7 | 18.10 | Drucker, Jimeno and Kangro (1915) |
| −17.4 | 11.87 | − 2.8 | 28.62 | |
| −20 | 9.92 | 150 | 4555 | Young (1910) |
| −10 | 18.81 | 160 | 5539 | „ |
| 0 | 33.08 | 170 | 6641 | „ |
| 10 | 55.65 | 180 | 7899 | „ |
| 20 | 89.55 | 190 | 9311 | „ |
| 30 | 139.6 | 200 | 10936 | „ |
| 40 | 210.9 | 210 | 12759 | „ |
| 50 | 309.0 | 220 | 14795 | „ |
| 60 | 439.0 | 230 | 17056 | „ |
| 70 | 613.8 | 240 | 19633 | „ |
| 90 | 1112 | 250 | 22414 | „ |
| 100 | 1457 | 260 | 25528 | „ |
| 110 | 1880 | 270 | 28991 | „ |
| 120 | 2391 | 280 | 32825 | „ |
| 130 | 3002 | 283.05 | 34133 | „ |
| 140 | 3725 | | | „ |
| 0 | 33.4 | 20 | 91.3 | Rex (1906) |
| 10 | 56.3 | 30 | 141.1 | „ |
| 0 | 33.4 | 28.53 | 132.9 | Van Dalfsen (1906) |
| 25 | 114.9 | | | Wood (1937) |
| 33.1 | 160.5 | 53.95 | 360 | Schreinemakers (1904) |
| 38.5 | 200 | 58.3 | 420 | „ |
| 44.3 | 250 | 62.2 | 480 | „ |
| 49.0 | 300 | 66.3 | 550 | „ |
| 34.8 | 175 | | | Kohnstamm and van Dalfsen (1901–1902) |
| 50 | 308 | | | Sackur (1910) |

*Boiling point:* All modern authors agree on this boiling point.

| | | | |
|---|---|---|---|
| 76°687 | Zmaczynski (1936) | 76°75 | Titani (1927) |
| 76°7 | Lacoss and Menzies (1937) | 76°75 | $\frac{dt}{dp}$ *(10 mm)* 0°44 B.E. (1926) and Lecat (passim) |
| 76°7 | Rex (1906) | | |
| 76°7 | Eftring (1938) | 76°75 | Young (1910) |
| 76°72 | Hoeppener and Antropoff (1930–1931) | 76°75 | Stull (1937) |
| 76°74 | Thorpe (1880) | 76°76 | Desreux (1935) |

*Freezing point:* All modern authors agree on this value.

| | | | |
|---|---|---|---|
| −22°85 | Skau (1933) | −22°96 | Staveley and Gupta (1949) |
| −22°95 | B.E. (1926) and Deffet (1935) | | |

*Transition point:* −47°41 Staveley and Gupta (1949)

*Melting curve:* Deffet (1935)

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|---|---|
| −22.95 | 1 | − 5.0 | 512 | 7.50 | 866 |
| −15.2 | 218 | 0.00 | 656 | 10.00 | 938 |
| −10.0 | 367 | 5.00 | 796 | | |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.63255 | B.E. (1926) | 17.15 | 1.59982 | Egerton and Lee (1923) |
| 15 | 1.60370 | „ | 17.75 | 1.59834 | „ |
| 30 | 1.57480 | „ | 18.26 | 1.59753 | „ |
| | | | 0 | 1.6327 | Desreux (1935) |
| 0 | 1.63257 | Young (1891–1910) | | | |
| 10 | 1.6132 | „ | 0 | 1.63262 | Biron (1910) |
| 17.60 | 1.59852 | „ | 12.3 | 1.6090 | Gladstone (1891) (Perkin's sample) |
| 20 | 1.5939 | „ | | | |
| 25 | 1.5843 | „ | 15 | 1.60365 | Perkin (1884) |
| 30 | 1.5748 | „ | | | |
| 40 | 1.5557 | „ | 20 | 1.5939 | Morino (1933) |
| | | | 20 | 1.5940 | Biron (1910) |
| 0 | 1.6325 | Cowley and Partington | 20 | 1.5940 | Eftring (1938) |
| 20 | 1.5941 | „ (1936) | | | |
| 40 | 1.5557 | „ | 20 | 1.5940 | Michielewicz (1938) |
| | | | 25 | 1.58445 | Zmaczynski (1936) |
| 19.35 | 1.5955 | Patterson and Thomson | 25 | 1.58452 | Scatchard, Wood and Mochel (1946) |
| 30.4 | 1.5742 | „ (1908) | | | |
| 15.67 | 1.60258 | Egerton and Lee (1923) | 25 | 1.58454 | Le Fevre and Le Fevre (1936) |
| 16.10 | 1.60182 | „ | | | |
| 16.49 | 1.60100 | „ | 25 | 1.58458 | Hubbard (1910) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0 | 1329 | B.E. (1926) | 20.00 | 965 | TITANI (1927) |
| 15 | 1038 | „ | 30.00 | 843 | „ |
| 30 | 845 | „ | 40.00 | 739 | „ |
| | | | 50.00 | 651 | „ |
| 10.01 | 1132 | KOLOSSOWSKI (1925) | 60.00 | 585 | „ |
| 13.53 | 1075 | „ | 70.00 | 527 | „ |
| 15.05 | 1048 | „ | 80.00 | 466 | „ |
| 18.13 | 1004 | „ | 90.00 | 426 | „ |
| 20.20 | 976 | „ | 100.00 | 383 | „ |
| 24.62 | 912 | „ | 110.00 | 352 | „ |
| 30.00 | 850 | „ | 120.00 | 322 | „ |
| 36.93 | 778 | „ | 130.00 | 299 | „ |
| 39.90 | 752 | „ | 140.00 | 276 | „ |
| 42.74 | 728 | „ | 150.00 | 255 | „ |
| | | | 160.00 | 234 | „ |
| 25 | 887.6 | LEWIS (1924) | 170.00 | 219 | „ |
| | | | 180.00 | 201 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 27.36 | B.E. (1926) | 0 | 29.38 | HARKINS and CHENG (1921) |
| 20 | 26.76 | „ | 10 | 28.05 | „ |
| 30 | 25.57 | „ | 20 | 26.70 | „ |
| | | | 30 | 25.54 | „ |
| 20 | 26.77 | DESREUX (1935) | 40 | 24.41 | „ |
| | | | 50 | 23.22 | „ |
| | | | 60 | 22.38 | „ |

*Refractive index*

| t° | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.46005 | 1.46305 | 1.46338 | 1.46882 | 1.46970 | 1.47405 | 1.47530 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00054 | 55 | 55 | — | 56 | — | 56 | „ |
| 20 | — | 1.46044 | — | — | — | — | — | ZMACZYNSKI (1936) |
| 25 | — | 1.45759 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.00057 | — | — | — | — | — | „ |
| 15 | — | 1.46325 | — | — | — | — | — | PAHLAVOUNI (1927) |
| 20 | — | 1.4602 | — | — | — | — | — | FISCHER and REICHEL (1943) |
| 20 | — | 1.46023 | — | — | — | — | — | STEARN and SMYTH (1934) |
| 20 | — | 1.46026 | — | — | — | — | — | SMYTH and ENGEL (1929) |
| 20 | — | 1.46036 | — | — | — | — | — | DAVIES (1936) |
| 25 | 1.45461 | 1.45732 | — | — | 1.46400 | — | 1.46954 | HUBBARD (1910) |
| 25 | — | 1.4576 | — | — | — | — | — | MICHIELEWICZ (1938) |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 20 | 2.2360 | DAVIES (1936) | 25 | 2.2270 | LE FEVRE (1938) |
| 25 | 2.2267 | „ | 40 | 2.2003 | „ |
| 0 | 2.275 | COWLEY and PARTINGTON | 50 | 2.1825 | „ |
| 20 | 2.234 | „ (1936) | 60 | 2.1650 | „ |
| 40 | 2.195 | „ | 70 | 2.1478 | „ |
| −10 | 2.2930 | LE FEVRE (1938) | 20 | 2.2488 | $\frac{d\varepsilon}{dt} = -0.0020$ PIETTE (unp.) |
| 0 | 2.2734 | „ | | | |
| 15 | 2.2447 | „ | | | |

**Heat constants**

*Specific heat:* STULL (1937)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| −183.16 | 0.1005 | −103.16 | 0.1420 | −23.16 | 0.1976 |
| −173.16 | 0.1053 | − 93.16 | 0.1480 | −13.16 | 0.2003 |
| −163.16 | 0.1093 | − 83.16 | 0.1536 | − 3.16 | 0.2026 |
| −153.16 | 0.1142 | − 73.16 | 0.1596 | + 6.84 | 0.2041 |
| −143.16 | 0.1190 | − 63.16 | 0.1655 | 16.84 | 0.2054 |
| −133.16 | 0.1247 | − 53.16 | 0.1718 | 26.84 | 0.2063 |
| −123.16 | 0.1303 | − 43.16 | 0.1779 | 36.84 | 0.2067 |
| −113.16 | 0.1364 | − 33.16 | 0.1872 | 46.84 | 0.2070 |
| 25 | 0.2066 | VOLD (1937) | | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 46.61 cal 15°/g | PITZER (1941) |
| *Heat of transition* | 9.258 „ | STAVELEY and GUPTA (1949) |
| *Heat of melting* | 5.085 „ | „ |

## TETRABROMOMETHANE or CARBON TETRABROMIDE $CBr_4$

**Constants**

*Melting point*

| | |
|---|---|
| 90°1 | FREDERICK and HILDEBRAND (1939) |
| 91°0 | VAN DER WERF, DAVIDSON and MICHAELIS (1948) |

*Transition point*

| | | | |
|---|---|---|---|
| 46.85 | SOHIER (1931) | 46.91 | ROTHMUND (1897) |
| 46.9 | FREDERICK and HILDEBRAND (1939) | 47.0 | VERSTRAETE (1934) |

| | | |
|---|---|---|
| *Heat of transition* | 4.282 cal 15°/g | FREDERICK and HILDEBRAND (1939) |
| *Heat of melting* | 2.85 „ | „ |

## MONOFLUOROTRICHLOROMETHANE $CFCl_3$

### Constants

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 198 | 43.2 | 0.554 | Benning and Mac Harness (1939) |

*Isotherms:* see Benning and Mac Harness (1940)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −36.673 | 47.35 | 10.362 | 463.46 | Osborne, Garner, Doescher and Yost |
| −21.825 | 108.15 | 15.108 | 556.15 | ,, (1941) |
| − 6.887 | 223.60 | 20.105 | 664.18 | ,, |
| + 2.352 | 354.61 | | | ,, |

*Boiling point:* 23°7 Benning and Mac Harness (1939)

*Melting point:* −110°48 Osborne, Garner, Doescher and Yost (1941)
−111° Benning and Mac Harness (1939)

*Specific heat:* Osborne, Garner, Doescher and Yost (1941) (M.W. 137.38)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −258.42 | 0.02221 | −221.09 | 0.07941 | L. −102.61 | 0.1906 |
| −257.33 | 0.02560 | −216.38 | 0.08225 | − 93.71 | 0.1920 |
| −256.03 | 0.02930 | −215.49 | 0.08276 | − 86.55 | 0.1934 |
| −254.09 | 0.03488 | −211.47 | 0.08523 | − 73.40 | 0.1947 |
| −251.82 | 0.04068 | −206.40 | 0.08836 | − 63.06 | 0.1964 |
| −249.64 | 0.04593 | −201.06 | 0.09142 | − 52.94 | 0.1978 |
| −247.42 | 0.05062 | −195.37 | 0.09506 | − 42.97 | 0.1985 |
| −244.89 | 0.05513 | −189.16 | 0.09863 | − 32.82 | 0.2010 |
| −241.95 | 0.05974 | −182.51 | 0.1027 | − 22.82 | 0.2026 |
| −238.65 | 0.06392 | −175.82 | 0.1067 | − 13.26 | 0.2043 |
| −234.94 | 0.06785 | −173.44 | 0.1107 | − 3.83 | 0.2060 |
| −231.06 | 0.07147 | −163.38 | 0.1145 | + 5.47 | 0.2077 |
| −226.38 | 0.07541 | −157.64 | 0.1182 | 14.66 | 0.2095 |

# DIFLUORODICHLOROMETHANE $CF_2Cl_2$

## Constants

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 111.5 | 39.56 | 0.555 | Bichowsky and Gilkey (1931) |

*Saturated vapour pressure*

| t° | p atm. | t° | p atm. | t° | p atm. | |
|---|---|---|---|---|---|---|
| −70 | 0.1217 | 0 | 3.045 | 70 | 18.48 | Gilkey, Gerard and Bixler |
| −60 | 0.2240 | 10 | 4.174 | 80 | 22.54 | „ (1931) |
| −50 | 0.3870 | 20 | 5.592 | 90 | 27.20 | „ |
| −40 | 0.6340 | 30 | 7.337 | 100 | 32.58 | „ |
| −30 | 0.9915 | 40 | 9.456 | 110 | 38.58 | „ |
| −20 | 1.490 | 50 | 11.99 | 111.5 | 39.56 | „ |
| −10 | 2.162 | 60 | 14.98 | | | „ |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | |
|---|---|---|---|
| −40 | 1.517 | 0.004097 | Bichowsky and Gilkey (1931) |
| −30 | 1.486 | 0.006199 | „ |
| −20 | 1.456 | 0.009037 | „ |
| −10 | 1.425 | 0.01280 | „ |
| 0 | 1.393 | 0.01765 | „ |
| 10 | 1.362 | 0.02379 | „ |
| 20 | 1.329 | 0.03149 | „ |
| 30 | 1.293 | 0.04111 | „ |
| 40 | 1.255 | 0.05313 | „ |
| 50 | 1.213 | 0.06856 | „ |
| 60 | 1.165 | 0.0875 | „ |
| 70 | 1.115 | 0.111 | „ |
| 80 | 1.056 | 0.142 | „ |
| 90 | 0.988 | 0.182 | „ |
| 100 | 0.898 | 0.242 | „ |
| 110 | 0.725 | 0.390 | „ |

*Heat of vaporisation* cal 15°/g

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| −29.8 | 40.4 | −23 | 33.9 | −28 | 32.8 | Buffington and Fleischer (1931) |

## B. HALOGENATED DERIVATIVES OF ETHANE

### ETHYL FLUORIDE $C_2H_5F$

This compound is prepared synthetically from potassium fluoride and diethylsulphate.

**Constants:** Booth and Swinehart (1935)

*Critical constants*

| t° cr. | p cr. atm. |
|---|---|
| 102.16 | 49.62 |

*Saturated vapour pressure*

| t° | p atm. | t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|---|---|
| 25.65 | 9.20 | 51.65 | 17.77 | 78.58 | 31.79 | 100.99 | 48.87 |
| 33.45 | 10.86 | 60.64 | 21.92 | 88.22 | 38.36 | 101.79 | 49.48 |
| 43.55 | 14.58 | 69.73 | 26.49 | 95.39 | 41.92 | 101.97 | 49.49 |

### ETHYL CHLORIDE $C_2H_5Cl$

**Constants:** B.E. (1937)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −55.877 | 22.45 | −19.994 | 188.41 | + 3.448 | 538.99 | Gordon and Giauque |
| −43.644 | 50.45 | −13.479 | 257.86 | 6.491 | 608.30 | „ (1948) |
| −35.441 | 82.45 | − 7.636 | 336.61 | 10.490 | 710.37 | „ |
| −28.085 | 124.13 | − 1.878 | 432.19 | 12.511 | 766.83 | „ |
| −32.0 | 98.30 | +30.0 | 1398.98 | 92.0 | 7362.30 | Regnault (1862) |
| − 1.0 | 446.30 | 61.0 | 3492.32 | | | „ |
| 8.75 | 661.4 | 16.7 | 889.3 | 17.7 | 921.5 | Schacherl (1880) |
| 11.0 | 719.9 | 17.1 | 905.4 | 18.9 | 958.5 | „ |
| 12.0 | 741.2 | 17.3 | 909.3 | 19.1 | 962.1 | „ |
| 13.4 | 786.6 | 17.4 | 913.0 | 20.5 | 1012.8 | „ |
| 14.0 | 800.4 | 17.5 | 914.7 | 23.5 | 1105.7 | „ |
| 16.3 | 874.7 | 17.6 | 918.7 | | | „ |
| 44.6 | 2219.2 | 122.7 | 13794.0 | 170.45 | 30704.0 | Berthoud (1917) |
| 66.4 | 4035.6 | 136.7 | 17476.4 | 175.0 | 33789.6 | „ |
| 83.3 | 6323.2 | 149.0 | 21812.0 | 182.4 | 36685.2 | „ |
| 98.1 | 8481.6 | 162.0 | 26866.0 | 187.2 | 39307.2 | „ |
| 111.3 | 11240.4 | 170.2 | 30628.0 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 12°28 | (interp.) Gordon and Giauque (1948) | 12°4 | Fuchs (1930) |
| 12°3 | $\frac{dt}{dp}$ *(10 mm)*; 0°41 B.E. (1937) | 12°4 | Lecat (passim) |
| 12°33 | (interp.) Schacherl (1880) | 12°5 | Beckmann (1907) |
| | | 12°5 | (interp.) Regnault (1862) |

*Freezing point*

| | | | |
|---|---|---|---|
| −136°4 | B.E. (1937) | −138°30 | Gordon and Giauque (1948) |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.92390 | B.E. (1937) |
| 10 | 0.90280 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 5 | 292 | B.E. (1937) |
| 10 | 279 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 5 | 21.20 | B.E. (1937) and Hennaut-Roland and Lek (1931) |
| 10 | 20.64 | „ „ |

*Refractive index:* $n_D^{0°}$ 1.3790 Fuchs (1930)

**Heat constants:** Gordon and Giauque (1948)

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|
| C. | −258.55 | 0.0186 | −198.40 | 0.1848 | −67.66 | 0.3548 |
| | −256.02 | 0.0299 | −193.14 | 0.1950 | −62.23 | 0.3553 |
| | −253.11 | 0.0423 | −187.43 | 0.2007 | −56.38 | 0.3574 |
| | −249.48 | 0.0560 | −181.60 | 0.2065 | −50.42 | 0.3577 |
| | −245.67 | 0.0699 | −175.61 | 0.2162 | −44.56 | 0.3599 |
| | −241.70 | 0.0832 | −169.36 | 0.2291 | −38.85 | 0.3605 |
| | −237.77 | 0.0958 | −162.91 | 0.2430 | −33.33 | 0.3619 |
| | −234.07 | 0.1080 | −157.20 | 0.2585 | −28.59 | 0.3636 |
| | −230.39 | 0.117 | −152.02 | 0.2764 | −22.81 | 0.3661 |
| | −226.49 | 0.127 | −146.28 | 0.3053 | −17.13 | 0.3686 |
| | −222.03 | 0.136 | L. −133.28 | 0.359 | −11.42 | 0.3698 |
| | −217.55 | 0.148 | −127.27 | 0.3576 | − 5.36 | 0.3725 |
| | −212.76 | 0.1581 | −122.01 | 0.3565 | + 0.57 | 0.3757 |
| | −207.95 | 0.1671 | −110.71 | 0.3551 | + 6.37 | 0.3783 |
| | −203.32 | 0.1758 | − 87.96 | 0.3545 | +11.37 | 0.3796 |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | (B.P.) 91.33 cal 15°/g | *Heat of melting* | 16.49 cal 15°/g |

## ETHYL BROMIDE $C_2H_5Br$

Concerning the bromide derivatives B.E. usually agree with SKAU, except for the densities, which are higher than ours. SKAU assigns this divergence to the presence of ether. We believe rather that his sample was contaminated by HBr.; this point has still to be cleared up. It is noteworthy, however, that our freezing points agree perfectly.

Note the existence of an azeotropic mixture with ethyl alcohol (B.P.: 37°6; with 3 % alcohol).

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 230.8 | 61.5 | 0.507 | HERZ and NEUKIRCH (1923) |

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| −24.0 | 46.80 | REGNAULT (1862) | 28.145 | 525.76 | ZMACZYNSKI (1930) |
| +16.0 | 330.05 | „ | 33.247 | 633.90 | „ |
| 56.0 | 1340.64 | „ | 43.560 | 906.1 | „ |
| 96.0 | 3927.48 | „ | 48.771 | 1074.6 | „ |
| 136.0 | 9088.95 | „ | 54.018 | 1268.1 | „ |
| | | | 59.300 | 1489.2 | „ |
| 0 | 165.2 | REX (1906) | 64.619 | 1741.0 | „ |
| 10 | 256.9 | „ | 69.974 | 2026.3 | „ |
| 20 | 385.9 | „ | 75.365 | 2347.4 | „ |
| 30 | 563.7 | „ | 0.32 | 165.8 | ROLAND (1928) |
| | | | 15.02 | 315.2 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 38°34 | SKAU and MAC CULLOUGH (1935) | 38°4 | ZEPALOVA-MICHAÏLOWA (1939) |
| 38°37 | REGNAULT (1862) | 38°4 | LECAT (passim) and B.E. (1926) |
| 38°386 | ZMACZYNSKI (1930) | 38°40 | TYRER (1914) |
| 38°4 | YOUNG (1921) | | |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°36 | B.E. (1926) and LECAT (passim) | 0°381 | ZMACZYNSKI (1930) |

*Freezing point*

| | | | |
|---|---|---|---|
| −118°6 | TIMMERMANS (1923) | −118°9 | SKAU and MAC CULLOUGH (1935) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.50136 | B.E. (1926) | 0 | 1.50138 | Timmermans (1923) |
| 15 | 1.47080 | „ | −23 | 1.54512 | „ |
| 30 | 1.44030 | „ | −63.3 | 1.62389 | „ |
| | | | −78.5 | 1.65400 | „ |
| | | | −111.6 | 1.71881 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 418 | B.E. (1926) | 77.8 | 233.6 | Heydweiller (1896) |
| 30 | 348 | „ | 100.5 | 198.2 | „ |
| 19.2 | 397.3 | Heydweiller (1896) | 129.0 | 161.9 | „ |
| 19.9 | 396.8 | „ | 130.0 | 161.3 | „ |
| 46.0 | 303.7 | „ | 160.0 | 125.3 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 24.83 | Hennaut-Roland and Lek (1931) |
| 20 | 24.15 | „ |
| 30 | 22.83 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42443 | 1.42470 | 1.42756 | 1.42771 | 1.43304 | 1.43420 | 1.43850 | 1.43976 |
| $\frac{dn}{dt}$ | — | 0.00055 | 56 | 56 | — | 57 | — | 58 |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 18 | 9.444 | Harrington (1916) | 10 | 9.71 | Le Fevre (1938) |
| −30 | 11.69 | Le Fevre (1938) | 25 | 9.01 | „ |
| −20 | 11.29 | „ | 35 | 8.59 | „ |
| −10 | 10.68 | „ | | | |
| 0 | 10.19 | „ | | | |

## ETHYL IODIDE $C_2H_5I$

Ethyl iodide forms an azeotrope with 13 % of ethyl alcohol and boiling at 63° (Lecat, 1918), or at 61°2 (Jana and Gupta, 1914).

New method of purification and criticism of the usual methods of purification. Gand (1943).

**Constants:** B.E. (1928). — **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 8.0 | 62.8 | Regnault (1862) | −100.06 | 0.0071 | Milazzo (1944) |
| 29.0 | 162.2 | „ | −99.26 | 0.008 | „ |
| 50.0 | 364.0 | „ | −78.46 | 0.1 | „ |
| 30 | 162.6 | Smyth and Engel (1929) | −62.66 | 0.5 | „ |
| 40 | 244.8 | „ | −19.36 | 14 | „ |
| 50 | 355.0 | „ | +0.04 | 41.5 | „ |
| 60 | 505.9 | „ | 9.34 | 65 | „ |
| 0 | 41.0 | Rex (1906) | 10.4 | 68 | „ |
| 10 | 68.1 | „ | 20.4 | 109.6 | „ |
| 30 | 166.2 | „ | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 72°18 | Robertson and Acree (1913) | 72°3 | Lecat (passim) |
| 72°27 | Schiff (1886) | 72°3 | Carrara and Coppadoro (1903) |
| 72°30 | B.E. (1928) | 72°42 | Gross and Saylor (1931) |
| 72°3 | Rex (1906) | 72°5 | Young (1921) |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°40 | B.E. (1928) | 0°42 | Lecat (passim) |

*Freezing point*

| | | |
|---|---|---|
| −110°9 | Timmermans (passim) | |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.98065 | B.E. (1928) | 11 | 1.9557 | Perkin (1896) |
| 15 | 1.94707 | „ | 15 | 1.9475 | „ |
| 30 | 1.91326 | „ | 25 | 1.92458 | Linebarger (1896) |
| 0 | 1.98038 | Tyrer (1914) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 617 | B.E. (1928) |
| 30 | 540 | „ |
| 20 | 593 | Gartenmesiter (1890) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 29.60 | Hennaut-Roland and |
| 20 | 28.83 | „ Lek (1931) |
| 30 | 27.57 | „ |

*Refractive index*

| t° | He r. | H$\alpha$ | D | He y. | He g. | H$\beta$ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.51158 | 1.51209 | 1.51682 | 1.51711 | 1.52646 | 1.52866 | 1.53618 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00060 | 62 | 63 | 64 | 64 | 65 | 64 | |

*Dielectric constant*

| t° | $\varepsilon$ | |
|---|---|---|
| 0 | 8.35 | Le Fevre (1938) |
| 10 | 8.00 | „ |
| 25 | 7.64 | „ |
| 35 | 7.37 | „ |
| 45 | 7.11 | Le Fevre (1938) |
| 55 | 6.90 | „ |
| 65 | 6.66 | „ |

*Specific magnetic rotatory power*

| | | |
|---|---|---|
| 11°0 | 2.2808 | Perkin (1896) |

## 1,2-DICHLOROETHANE or ETHYLENE DICHLORIDE $(CH_2Cl)_2$

The large discrepancies found in the literature are presumably due to the presence of polyhalogenated derivatives.

**Constants:** B.E. (1928). — **Polyphasic equilibria**

*Saturated vapour pressure*

| | | |
|---|---|---|
| 50° | 236 mm | Zawidzki (1900) |

*Boiling point*

| | | | | | |
|---|---|---|---|---|---|
| 83°45 | $\frac{dt}{dp}$ (10 mm); | 0°45 | Lecat (passim) | 83°5 | Coulson, Hales and Herington |
| $83°48_3$ | „ | $0°420_4$ | Smith and Matheson (1938) | 83°6 | Schiff (1884) (1948) |
| 83°50 | „ | 0°46 | B.E. (1928) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −35°3 | TIMMERMANS (passim) | −35°5 | RAILING (1939) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.28164 | B.E. (1928) | 20 | 1.2528 | EFTRING (1938) |
| 15 | 1.26000 | „ | 20 | 1.2529 | COULSON, HALES and HERINGTON (1948) |
| 30 | 1.23831 | „ | 25 | 1.2453 | SEARS and HOPKE (1949) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 887 | B.E. (1928) |
| 30 | 730 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 32.93 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 32.23 | „ |
| 30 | 30.84 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 1.44481 | 1.44517 | 1.44759 | 1.44771 | 1.45257 | 1.45375 | 1.45747 | 1.45866 | B.E. (1928) |
| $\frac{n}{t}$ | 0.00050 | 50 | 51 | 51 | 52 | 52 | 52 | 52 | „ |
| 0 | — | — | 1.4449 | — | — | — | — | — | COULSON, HALES and HERINGTON (1948) |
| 0 | — | — | 1.44507 | — | — | — | — | — | PAHLAVOUNI (1927) |
| 0 | — | 1.44240 | — | — | — | — | — | — | HAMAI (1933) |
| $\frac{n}{t}$ | — | 0.000523 | — | — | — | — | — | — | „ |

## Heat constants

| | | |
|---|---|---|
| *Heat of melting* | 21.12 cal 15°/g | RAILING (1939) |
| *Heat of combustion* | 20° ($c_v$) 2993.3 „ | EFTRING (1938) |

## 1.1-DICHLOROETHANE or ETHYLIDENE DICHLORIDE $CH_3—CHCl_2$

This product is easy to purify. According to LECAT (1918), it forms with ethyl alcohol an azeotrope with 8 % alcohol, boiling at 54°5.

**Constants:** B.E. (1926)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 0 | 70.1 | REX (1906) | 20 | 182.1 | REX (1906) |
| 10 | 115.3 | „ | 30 | 277.2 | „ |

*Boiling point*

| | |
|---|---|
| 57°1 | HENNE and HUBBARD (1936) |
| 57°25 | $\frac{dt}{dp}$ *(10 mm)*; 0°42 LECAT (passim) |
| 57°30 | „ 0°42 B.E. (1926) |

*Freezing point*

| | |
|---|---|
| −97°4 | HENNE and HUBBARD (1936) |
| −97°8 | TIMMERMANS |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.20685 | B.E. (1926) | 20 | 1.1755 | HENNE and HUBBARD (1936) |
| 15 | 1.18350 | „ | | | |
| 30 | 1.16010 | „ | 20 | 1.1760 | EFTRING (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 505 | B.E. (1926) |
| 30 | 430 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 25.32 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 24.75 | „ |
| 30 | 23.62 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41677 | 1.41735 | 1.41975 | 1.41990 | 1.42421 | 1.42555 | 1.42871 | 1.43030 | B.E. (1926) |
| $\frac{dn}{dt}$ | — | 0.00052 | 53 | 53 | — | 53 | — | 53 | „ |
| 20 | — | 1.41385 | 1.41638 | — | — | 1.42213 | — | — | HENNE and HUBBARD (1936) |

The disagreement between our values and those of HENNE and HUBBARD is unaccountable.

## 1,2-DIBROMOETHANE or ETHYLENE DIBROMIDE $(CH_2Br)_2$

This compound must be purified by fractional fusion. The best criterion of purity is the freezing point.

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Boiling point*

| | | | |
|---|---|---|---|
| 131°6<br>131°65 | Beckmann (1890)<br>$\frac{dt}{dp}$ *(10 mm)*; 0°48 Lecat (passim) | 131°70 | $\frac{dt}{dp}$ *(10 mm)*: 0°48 B.E. (1926) |

*Freezing point*

| | | | |
|---|---|---|---|
| 9°93 | Railing (1939) | 9°97 | Leblanc and Möbius (1933) |
| 9°95 | Scheuer (1910) | 9°975 | Moles (1912) |
| 9°95 | Desreux (1935) | 10°00 | B.E. (1926) |
| 9°95 | Deffet (1935) | 10°012 | Biron (1912) |

*Melting curve:* Deffet (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 9.95 | 1 | 28.00 | 733 |
| 15.00 | 201 | 32.00 | 888 |
| 20.00 | 405 | 34.50 | 988 |
| 25.00 | 610 | 38.00 | (1130) |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 2.1911 | B.E. (1926) | 10.5 | 2.2008 | Gladstone (1891) |
| 30 | 2.1597 | „ | 20 | 2.1804 | Biron (1912) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 1880 | B.E. (1926) | 67.3 | 922 | Scheuer (1910) |
| 30 | 1490 | „ | 82.2 | 750 | „ |
| 25 | 1605 | Dunstan, Hilditsch and Thole (1913) | 99.0 | 648 | „ |

*Surface tension*

| t° | γ | | t° | γ | |
|---|---|---|---|---|---|
| 15 | 39.66 | Hennaut-Roland and | 30 | 37.61 | Hennaut-Roland and Lek (1931) |
| 20 | 38.91 | „ Lek (1931) | 20 | 38.91 | Desreux (1935) |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ | |
|---|---|---|---|---|---|---|
| 15 | 1.53743 | 1.54160 | 1.54167 | 1.55168 | 1.56024 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00058 | 58 | 58 | 58 | 58 | „ |

**Heat constants**

*Specific heat:* Le Blanc and Möbius (1933)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. 4.60 | 0.1310 | L. 10.18 | 0.1768 | 16.20 | 0.1721 |
| 6.61 | 0.1311 | 11.45 | 0.1748 | 18.20 | 0.1714 |
| 7.53 | 0.1311 | 14.42 | 0.1728 | 25.37 | 0.1716 |

| | | |
|---|---|---|
| *Heat of melting* | 13.79 cal 15°/g | Railing (1939) |

Verhulst and Jungers (1949); Wuyts and Jungers (1949) and D'Hondt and Jungers (1949) have studied the deutero di and tribromomethanes.

## 1.1.1-TRIFLUOROETHANE or METHYLFLUOROFORM $CF_3—CH_3$

**Constants:** Russel Jr., Golding and Yost (1944)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −99.546 | 26.17 | −70.947 | 213.14 | −54.315 | 538.79 |
| −87.303 | 70.62 | −64.321 | 314.91 | −50.618 | 648.04 |
| −77.73 | 138.41 | −58.945 | 423.26 | −47.370 | 757.62 |

*Boiling point*
−47°305 (calc.)

*Melting point*
−111°34

*Specific heat:* (M.W. 84.044)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −260.835 | 0.01836 | −239.082 | 0.09133 | −167.005 | 0.1813 |
| −259.947 | 0.02123 | −238.680 | 0.09225 | −159.171 | 0.1904 |
| −259.879 | 0.02152 | −235.312 | 0.09942 | −151.203 | 0.2002 |
| −258.579 | 0.02681 | −234.430 | 0.1009 | −143.265 | 0.2116 |
| −258.535 | 0.02699 | −231.269 | 0.1068 | −135.306 | 0.2253 |
| −257.125 | 0.03251 | −226.977 | 0.1144 | −131.455 | 0.2330 |
| −257.099 | 0.03262 | −222.334 | 0.1210 | −127.192 | 0.2435 |
| −255.431 | 0.03932 | −217.348 | 0.1275 | | |
| −255.222 | 0.04019 | −216.107 | 0.1290 | L. −107.753 | 0.2892 |
| −253.367 | 0.04746 | −212.116 | 0.1335 | −107.352 | 0.2895 |
| −252.965 | 0.04895 | −209.957 | 0.1359 | −102.652 | 0.2907 |
| −250.791 | 0.05697 | −206.581 | 0.1396 | −101.159 | 0.2912 |
| −250.453 | 0.05822 | −203.462 | 0.1429 | − 95.575 | 0.2930 |
| −248.676 | 0.06646 | −196.533 | 0.1502 | − 93.950 | 0.2936 |
| −247.728 | 0.06762 | −189.250 | 0.1577 | − 86.128 | 0.2964 |
| −245.291 | 0.07511 | −182.265 | 0.1647 | − 77.638 | 0.3006 |
| −245.093 | 0.07564 | −181.519 | 0.1657 | − 69.471 | 0.3035 |
| −242.354 | 0.08321 | −174.696 | 0.1726 | − 60.714 | 0.3077 |
| −242.218 | 0.08358 | −173.618 | 0.1737 | − 52.417 | 0.3123 |

| *Heat of vaporisation* | *Heat of melting* | *Heat of transition* |
|---|---|---|
| (−48°76/0.9339 atm) 54.52 cal 15°/g | 17.61 cal 15°/g | 0.8400 → 0.8439 cal 15°/g |

## 1,1,2-TRICHLOROETHANE $CH_2Cl—CHCl_2$

**Constants**

*Boiling point*

| | |
|---|---|
| 113°3 | Henne and Hubbard (1936) |
| 113°5 | Timmermans (1913) |
| 113°65 | Lecat |

*Freezing point*

| | |
|---|---|
| −36°65 | Timmermans (1913) |
| −37°4 | Henne and Hubbard (1936) |

*Density*

| t° | d | |
|---|---|---|
| 20 | 1.4405 | Desreux (1935) |
| 20 | 1.4411 | Henne and Hubbard (1936) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20° | 33.57 | Desreux (1935) |

*Refractive index*

| t° | Hα | D | Hβ | |
|---|---|---|---|---|
| 20 | 1.46798 | 1.47064 | 1.47731 | Henne and Hubbard (1936) |

## 1,1,1-TRICHLOROETHANE or METHYLCHLOROFORM $CH_3-CCl_3$

**Constants:** B.E. (unp.)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −5.364 | 28.8 | 11.304 | 69.3 | Rubin, Levedahl and Yost (1944) |
| +5.109 | 50.5 | 16.923 | 91.2 | |

*Boiling point*

| | |
|---|---|
| 73°9 | Henne and Hubbard (1936) |
| 74°0 | $\frac{dt}{dp}$ *(10 mm)*: 0°44 B.E. (unp.) |
| 74°0 | Turkevich and Smyth (1940) |

*Freezing point*

| | |
|---|---|
| −32°2 | Van de Vloed (1938) |
| −32°7 | Turkevich and Smyth (1940) |
| −32°96 | Rubin, Levedahl and Yost (1944) |

*Transition point:* −48°96 Rubin, Levedahl and Yost (1944)

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.37068 | B.E. (unp.) |
| 15 | 1.34587 | „ |
| 30 | 1.32096 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 903 | B.E. (unp.) |
| 30 | 725 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 26.17 | B.E. (unp.) |
| 20 | 25.56 | „ |
| 30 | 24.25 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.43787 | 1.43832 | — | 1.44097 | 1.44592 | 1.44711 | 1.45099 | — | B.E. (unp.) |
| $\frac{dn}{dt}$ | 0.00051 | 51 | — | 52 | 53 | 52 | 55 | — | „ |
| 20 | — | — | 1.4379 | — | — | — | — | — | Turkevich and Smyth (1940) |

*Specific heat:* RUBIN, LEVEDAHL and YOST (1944) (M.W. 133.415)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. I −260.87 | 0.0105 | −199.94 | 0.09641 | −63.65 | 0.2348 |
| −259.83 | 0.0142 | −192.07 | 0.1026 | −60.26 | 0.2544 |
| −258.79 | 0.0175 | −183.57 | 0.1091 | −57.15 | 0.2855 |
| −257.68 | 0.0214 | −174.59 | 0.1157 | −54.35 | 0.3385 |
| −255.66 | 0.0264 | −171.32 | 0.1181 | C. II −47.03 | 0.2600 |
| −253.55 | 0.0322 | −163.30 | 0.1235 | −44.25 | 0.2818 |
| −251.48 | 0.0373 | −155.42 | 0.1296 | −42.33 | 0.3050 |
| −249.12 | 0.04277 | −147.43 | 0.1358 | L. −27.76 | 0.2499 |
| −246.14 | 0.05012 | −139.32 | 0.1416 | −21.55 | 0.2508 |
| −242.80 | 0.05593 | −131.30 | 0.1474 | −15.36 | 0.2516 |
| −239.33 | 0.06128 | −116.11 | 0.1593 | − 9.35 | 0.2527 |
| −235.41 | 0.06637 | −108.90 | 0.1649 | + 2.69 | 0.2541 |
| −230.73 | 0.07136 | −101.89 | 0.1695 | 8.69 | 0.2553 |
| −225.56 | 0.07661 | − 95.08 | 0.1755 | 14.54 | 0.2565 |
| −219.76 | 0.08164 | − 82.94 | 0.1863 | 20.55 | 0.2574 |
| −213.60 | 0.08614 | − 77.87 | 0.1947 | 26.43 | 0.2585 |
| −207.33 | 0.09094 | | | | |

## 1,1-DIFLUORO-2-BROMOETHANE $CH_2Br—CHF_2$

### Constants

*Density*

| t° | d | |
|---|---|---|
| 10.5 | 1.83685 | SWARTS (1923) |
| 20 | 1.8169 | DESREUX (1935) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 20.05 | 784 | SWARTS (1931) | 40 | 620.5 | SWARTS (1931) |
| 30 | 696.5 | „ | 50.45 | 555 | „ |

*Surface tension:* 20° 27.02 DESREUX (1935)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 10.5 | 1.39300 | 1.39400 | 1.39772 | 1.40470 | SWARTS (1923) |

## 1.1.2.2-TETRACHLOROETHANE (ACETYLENE TETRACHLORIDE) $(CHCl_2)_2$

**Constants:** B.E. (1926)

*Boiling point*

| | |
|---|---|
| 146°2 | EFTRING (1938) |
| 146°2 | $\frac{dt}{dp}$ *(10 mm);* 0°51 LECAT (passim) |
| 146°20 | „ 0°50 B.E. (1926) |

*Freezing point:* −42°5 TIMMERMANS (passim)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.62640 | B.E. (1926) | 17 | 1.5995 | VELEY (1909) |
| 15 | 1.60255 | „ | 22.5 | 1.5908 | WALDEN and SWINNE |
| 30 | 1.57860 | „ | 25 | 1.5869 | „ (1913) |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 1844 | B.E. (1926) | 20 | 36.04 | EFTRING (1938) |
| 30 | 1456 | „ | 40 | 33.30 | „ |
| 10 | 2059 | DRUCKER and KASSEL (1911) | | | |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ | |
|---|---|---|---|---|---|---|
| 15 | 1.49392 | 1.49678 | 1.49680 | 1.50381 | 1.50654 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00051 | 51 | — | 51 | 51 | „ |
| 17 | — | 1.495587 | — | — | — | VELEY (1909) |
| 18.5 | 1.49209 | 1.49490 | — | 1.50188 | — | COTTON and MOUTON (1913) |

| | | |
|---|---|---|
| *Heat of combustion* | 20° $(c_v)$ 1370.8 cal 15°/g | EFTRING (1938) |

## 1,1,2,2-TETRABROMOETHANE (ACETYLENE TETRABROMIDE) ($CHBr_2$)

### Constants

*Boiling point:* 134° Swarts (1897)

*Melting point:* 0° Timmermans (1913)
0°13 Lespieau (1919)

*Density*

| t° | d | t° | d | |
|---|---|---|---|---|
| 19.3 | 2.9656 | 50.0 | 2.8970 | Walden and Swinne (1913) |
| 25.0 | 2.9529 | 73.5 | 2.8444 | „ |
| 46.0 | 2.9056 | 100.7 | 2.7834 | „ |
| | | 20 | 2.9656 | Swarts (1897) |

*Refractive index* $n_D^{20°}$: 1.63795 Swarts (1897)

## 1-FLUORO-1,2,2-TRICHLOROETHANE $CHClF—CHCl_2$

### Constants

*Density*

| t° | d | |
|---|---|---|
| 17.2 | 1.5492 | Swarts (1923) |
| 20 | 1.5393 | Desreux (1935) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 20 | 1070 | Swarts (1931) | 50 | 727 | Swarts (1931) |
| 30 | 929 | „ | 60 | 651 | „ |
| 40 | 819 | „ | | | |

*Surface tension:* 20° 29.95 Desreux (1935)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 17.2 | 1.4377 | 1.4400 | 1.4457 | 1.45073 | Swarts (1923) |

## 1,1-DIFLUORO – 2,2-DICHLOROETHANE $CHCl_2—CHF_2$

### Constants

*Density:* 16°4 1.4945 SWARTS (1923)

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 20 | 713 | 50 | 494 | SWARTS (1931) |
| 30 | 626 | 55 | 468 | „ |
| 40 | 554 | | | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 16.4 | 1.38108 | 1.38303 | 1.39770 | 1.39216 | SWARTS (1923) |

| | 1,1-DICHLORO-1,2-DIBROMOETHANE $CH_2Br—CCl_2Br$ | | 1,1-DICHLORO-1,2,2-TRIBROMOETHANE $CHBr_2—CCl_2Br$ | |
|---|---|---|---|---|
| **Constants:** VAN DE WALLE (1925) | | | | |
| *Boiling point* | 175° | | 210° | |
| *Melting point* | −66°85 | TIMMERMANS | +16°8 | |
| *Density* | t° | d | t° | d |
| | 0 | 2.2998 | 15 | 2.6315 |
| | 15 | 2.2695 | 30 | 2.6009 |
| | 30 | 2.1957 | | |
| *Viscosity* | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
| | 0 | 5361 | 15 | 13457 |
| | 15 | 3755 | 30 | 8385 |
| | 30 | 2678 | | |
| *Refractive index* | 15° | — | 15° | 30° |
| Hα | 1.5525 | — | 1.60138 | 1.59456 |
| D | 1.55930 | — | 1.60724 | 1.60035 |
| Hβ | 1.56917 | — | 1.62095 | 1.61089 |

## PENTACHLOROETHANE $C_2HCl_5$

**Constants:** B.E. (1926)

*Boiling point:* 162° $\frac{dt}{dp}$ *(10 mm):* 0°54 B.E. (1926) and LECAT (passim)

*Freezing point:* −29°0 B.E. (1926) and DEFFET (1935)

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| −29.0 | 1 | −20.0 | 406 |
| −26.5 | 113 | −14.0 | 680 |
| −24.2 | 213 | − 7.5 | 972 |

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.71100 | B.E. (1926) |
| 15 | 1.68813 | „ |
| 30 | 1.66530 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2751 | B.E. (1926) |
| 30 | 2070 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 35.30 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 34.72 | „ |
| 30 | 33.58 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.50198 | 1.50250 | 1.50542 | 1.50545 | 1.51121 | 1.51270 | 1.51702 | 1.51870 |
| $\frac{dn}{dt}$ | — | 0.00046 | 46 | 46 | — | 47 | — | 47 |

## HEXACHLOROETHANE $C_2Cl_6$

### Constants

*Saturated vapour pressure*

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| C. | 62.1 | 6.0 | 149.0 | 248 | 191.7 | 904 | Van der Lee (1935) |
| | 72.6 | 10 | 153.4 | 291 | 193.5 | 941 | „ |
| | 73.7 | 11.5 | 154.9 | 304 | 197.9 | 1037 | „ |
| | 83.4 | 18 | 158.2 | 334 | 198 | 1052 | „ |
| | 96.7 | 32 | 158.8 | 348 | 200.2 | 1094 | „ |
| | 108.9 | 53 | 165.0 | 408 | 204.3 | 1190 | „ |
| | 118.0 | 80 | 170.5 | 502 | 208.1 | 1302 | „ |
| | 118.3 | 81 | 173.2 | 535 | 212.6 | 1391 | „ |
| | 119.9 | 83 | 173.6 | 545 | 213.5 | 1444 | „ |
| | 123.9 | 102 | 177.0 | 607 | 214.3 | 1457 | „ |
| | 128.3 | 120 | 180.3 | 672 | 214.8 | 1497 | „ |
| | 129.1 | 123 | 180.7 | 678 | 216.2 | 1539 | „ |
| | 131.0 | 131 | 182.6 | 722 | 224.2 | 1801 | „ |
| | 133.3 | 143 | 183.4 | 737 | 228.8 | 1965 | „ |
| | 136.5 | 161 | 184.8 | 769 | 234.8 | 2159 | „ |
| | 138.4 | 167 | L. 189.6 | 869 | 239.1 | 2380 | „ |
| C. | 12.94 | 0.20 | 61.74 | 5.1 | 110.34 | 57.2 | Ivin and Dainton |
| | 30.44 | 0.60 | 64.94 | 6.1 | 117.14 | 74.8 | „ (1947) |
| | 34.34 | 0.80 | 67.64 | 7.15 | 132.34 | 137.8 | „ |
| | 40.74 | 1.25 | 76.64 | 11.7 | 139.24 | 175.0 | „ |
| | 44.74 | 1.65 | 79.54 | 13.75 | 149.84 | 254.7 | „ |
| | 47.34 | 1.85 | 90.04 | 22.6 | 161.44 | 373.0 | „ |
| | 53.04 | 2.85 | 99.94 | 36.2 | 174.44 | 559.3 | „ |

*Boiling point:* 184°4 Van der Lee (1935)
184°8 Lecat

*Triple point*

| | |
|---|---|
| −186°8 | Van der Lee (1935) |
| −186°8 | Wiebenga (1935) |

*Transition points*

| | | |
|---|---|---|
| Rhombic → Triclinic: | 43°6 | Wiebenga (1935) |
| | 45° | Steinmetz (1905) |
| Triclinic → Cubic: | 71° | Steinmetz (1905) |
| | 71°1 | Wiebenga (1935) |
| | 71°6 | Pascal (1912) |
| | 72° | Ivin and Dainton (1947) |

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_p$) 721.3 cal 15 g | Eftring (1938) |

## 1,2-DIFLUOROTETRACHLOROETHANE $(CCl_2F)_2$

**Constants:** Locke, Brode and Henne (1934)

*Boiling point:* 92°8 *Melting point:* 24°65

*Density* *Refractive index*

| t° | d | | t° | Hα | D | Hβ |
|---|---|---|---|---|---|---|
| 25 | 1.64470 | | 25 | 1.41100 | 1.41297 | 1.41823 |
| 35 | 1.62516 | | 35 | 1.40656 | 1.40831 | 1.41368 |
| | | | $\frac{dn}{dt}$ | 0.00044 | 47 | 45 |

## 1,1,2-TRIFLUORO-1,2,2-TRICHLOROETHANE $CF_2Cl—CCl_2F$

**Constants**

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 214.1 | 33.7 | 0.576 | Benning and Mac Harness (1939) |

*Isotherms:* see Benning and Mac Harness (1940)

*Boiling point* *Melting point*

| | | | |
|---|---|---|---|
| 47°4 | Swarts (1931) | −35° | Benning and Mac Harness (1939) |
| 47°6 | Benning and Mac Harness (1939) | −36°4 | Swarts (1931) |
| | | −36°4 | Locke, Brode and Henne (1934) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.6200 | Locke, Brode and Henne | 35 | 1.53982 | Locke, Brode and Henne |
| 25 | 1.56354 | „ (1934) | 0 | 1.6200 | Swarts (1931) (1934) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 20 | 698 | 40 | 546.5 | Swarts (1931) |
| 30 | 614 | 45 | 516 | „ |

*Refractive index*

| t° | Hα | D | Hβ | |
|---|---|---|---|---|
| 25 | 1.35413 | 1.35572 | 1.35981 | Locke, Brode and Henne (1934) |
| 35 | 1.34933 | 1.35124 | 1.35488 | „ |
| $\frac{dn}{dt}$ | 0.00048 | 45 | 49 | „ |

## C. HALOGENATED DERIVATIVES OF PROPANE

### *n*-PROPYL CHLORIDE $C_2H_5—CH_2Cl$

**Constants:** B.E. (1930)

*Critical constants:* t cr: 230.05; p cr. atm: 45.18 BERTHOUD (1917)

*Saturated vapour pressure*

| t° | p atm. | t° | p atm. | |
|---|---|---|---|---|
| 45.55 | 0.956 | 174.8 | 20.28 | BERTHOUD (1917) |
| 64.2 | 1.86 | 188.2 | 24.89 | „ |
| 92.5 | 4.03 | 199.5 | 29.49 | „ |
| 111.0 | 6.11 | 207.8 | 33.13 | „ |
| 132.6 | 9.74 | 214.65 | 36.32 | „ |
| 150.2 | 13.56 | 225.35 | 42.08 | „ |
| 165.55 | 17.54 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 46°60 | $\frac{dt}{dp}$ *(10 mm)*; 0°37 B.E. (1930) | 46°80 | (interp.) BERTHOUD (1917) |
| | | 47°17 | EFTRING (1938) |
| 46°65 | $\frac{dt}{dp}$ *(10 mm)*; 0°38 LECAT (passim) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −122°3 | MARTIN and HUMPHREY (1947) | −122°8 | B.E. (1930) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.91686 | B.E. (1930) | 30 | 0.87994 | B.E. (1930) |
| 15 | 0.89846 | „ | 20 | 0.8924 | EFTRING (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 372 | B.E. (1930) |
| 30 | 318 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 22.45 | B.E. (1930) |
| 20 | 21.78 | „ |
| 30 | 20.48 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.38884 | 1.38924 | 1.39142 | 1.39544 | 1.39645 | 1.39947 | 1.40059 |
| $\frac{dn}{dt}$ | 0.00053 | 52 | 54 | 54 | 56 | 57 | 58 |

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_v$) 6210.4 cal 15°/g | Eftring (1938) |

## *Iso*-PROPYL CHLORIDE $(CH_3)_2CHCl$

**Constants:** B.E. (1928)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 0 | 191.7 | 20 | 435.5 | Rex (1906) |
| 10 | 291.5 | 30 | 629.7 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 34°8 | $\frac{dt}{dp}$ *(10 mm)*; 0°34 B.E. (1928) | 34°8 | Rex (1906) |
| | | 34°9 | Lecat (passim) |

*Freezing point*

| | |
|---|---|
| −117°0 | B.E. (1928) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.88690 | B.E. (1928) | 15 | 0.86812 | Perkin (1885) |
| 15 | 0.86797 | „ | 25 | 0.85503 | „ |
| 30 | 0.84910 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 335 | B.E. (1928) |
| 30 | 286 | „ |

*Refractive index*

| t° | Hα | D | He y. | Hβ |
|---|---|---|---|---|
| 15 | 1.37900 | 1.38110 | 1.38141 | 1.38620 |
| $\frac{dn}{dt}$ | 0.00055 | 56 | 56 | 56 |

## *n*-PROPYL BROMIDE $C_2H_5—CH_2Br$

*n*-Propyl bromide gives with *n*-propyl alcohol an azeotrope with 10 % of alcohol boiling at 69°75, according to HOLLEY (1902) or with only 9 % alcohol, boiling at 69°2, according to LECAT (1918).

**Constants:** B.E. (1926)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 0 | 41.6 | 20 | 110.8 | REX (1906) |
| 10 | 68.19 | 30 | 170.6 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 70°92 | SCHIFF (1884) | 71°00 | LECAT (passim) and B.E. (1926) |
| 70°97 | SKAU and MAC CULLOUGH (1935) | 71°00 | ZANDER (1882) |
| | | 71°00 | HILDITCH and DUNSTAN (1911) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°34 | B.E. (1926) | 0·35 | LECAT (passim) |

*Freezing point*

| | | | |
|---|---|---|---|
| −109°8 | SKAU and MAC CULLOUGH (1935 | −110°0 | B.E. (1926) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.38455 | B.E. (1926) | 20 | 1.3515 | GARTENMEISTER (1890) |
| 15 | 1.35965 | „ | 25 | 1.3455 | SKAU and MAC CULLOUGH (1935) |
| 30 | 1.33475 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 539 | B.E. (1926) |
| 30 | 459 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 26.48 | HENNAUT-ROLAND and LEK (1931) | 30 | 24.59 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 25.85 | „ | 10 | 27.08 | SCHIFF (1884) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.43379 | 1.43440 | 1.43695 | 1.43700 | 1.44248 | 1.44384 | 1.44784 | 1.44949 |
| $\frac{dn}{dt}$ | — | 0.00052 | 52 | — | — | 53 | — | 53 |

## *Iso*-PROPYL BROMIDE $(CH_3)_2CHBr$

This compound gives with *iso*-propyl alcohol an azeotrope with 12 % of *iso*-propyl alcohol, boiling at 57°8: (LECAT, 1918).

**Constants:** B.E. (1928)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 0 | 69.1 | REX (1906) | 20 | 175.4 | REX (1906) |
| 10 | 111.4 | „ | 30 | 264.2 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 59°35 | $\frac{dt}{dp}$ *(10 mm)*; 0°37 B.E. (1928) | 59°41 | Skau and Mac Cullough (1935) |
| 59°4 | $\frac{dt}{dp}$ *(10 mm)*; 0°36 Lecat (passim) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −89°0 | B.E. (1928) | −90°0 | Skau and Mac Cullough (1935) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.34715 | B.E. (1928) | 30 | 1.29720 | B.E. (1928) |
| 15 | 1.32223 | „ | 25 | 1.3063 | Skau and Mac Cullough (1935) |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 536 | B.E. (1928) | 15 | 23.56 | Hennaut-Roland and Lek (1931) |
| 30 | 437 | „ | 20 | 22.90 | „ |
| | | | 30 | 21.74 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42540 | 1.42566 | 1.42847 | 1.42865 | 1.43403 | 1.43520 | 1.43959 | 1.44045 |
| $\frac{dn}{dt}$ | 0.00056 | 56 | 57 | 57 | 58 | 58 | 58 | 58 |

## *n*-PROPYL IODIDE $C_2H_5—CH_2I$

This compound gives with *n*-propyl alcohol an azeotrope with 30 % of alcohol, boiling at 90°2. (Lecat; 1918).

**Constants:** B.E. (1934)

*Saturated vapour pressure:* see Milazzo (1944)

*Boiling point*

| | | | |
|---|---|---|---|
| 102°4 | Lecat (passim) | 102°5 | Dobriner (1888) |
| 102°45 | $\frac{dt}{dp}$ *(10 mm)*; 0°47 B.E. (1934) | 102°5 | Zander (1882) |

*Freezing point:* — 98°7 B.E. (1934)

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.78673 | B.E. (1934) |
| 15 | 1.75840 | „ |
| 30 | 1.72997 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 837 | B.E. (1934) |
| 30 | 670 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 30.11 | Bodson (1937) | 14 | 30.20 | Schiff (1884) |
| 20 | 29.56 | „ | 40 | 27.07 | „ |
| 30 | 28.47 | „ | | | |
| 40 | 27.40 | „ | | | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ |
|---|---|---|---|---|---|
| 15 | 1.50386 | 1.50448 | 1.50890 | 1.51738 | 1.51925 |
| $\frac{dn}{dt}$ | 0.00060 | 60 | 62 | 63 | 65 |

## *Iso*-PROPYL IODIDE $(CH_3)_2CHI$

**Constants:** B.E. (1934)

*Saturated vapour pressure:* see Milazzo (1944)

| t° | p mm | |
|---|---|---|
| 0 | 21.1 | Rex (1906) |
| 20 | 56.4 | „ |
| 30 | 88.4 | „ |

*Boiling point*

| | | |
|---|---|---|
| 89°45 | | Lecat (passim) |
| 89°45 | $\frac{dt}{dp}$ *(10 mm):* 0°45 | B.E. (1934) |
| 89°5 | | Hughes and Shapiro (1937) |

*Freezing point:* −90°0 TIMMERMANS (passim)

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.74246 | B.E. (1934) |
| 15 | 1.71371 | „ |
| 30 | 1.68503 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 732 | B.E. (1934) |
| 30 | 620 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 20 | 27.42 | BODSON (1937) | 50 | 23.63 | BODSON (1937) |
| 30 | 26.13 | „ | 60 | 22.37 | „ |
| 40 | 24.87 | „ | 70 | 21.12 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.49698 | 1.49763 | 1.50224 | 1.51111 | 1.51321 | 1.52003 |
| $\frac{dn}{dt}$ | 0.00058 | 58 | 58 | 59 | 59 | 59 |

## PROPYLENE DICHLORIDE or 1.2-DICHLOROPROPANE

$CH_3—CHCl—CH_2Cl$

**Constants**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 15 | 33.0 | 50 | 154.7 | 85 | 539.1 | NELSON and YOUNG (1933) |
| 20 | 42.0 | 55 | 188.0 | 90 | 630.5 | „ |
| 25 | 54.0 | 60 | 227.4 | 95 | 733.5 | „ |
| 30 | 67.5 | 65 | 273.0 | 96 | 754.0 | „ |
| 35 | 84.0 | 70 | 326.8 | 99.7 | 847.1 | „ |
| 40 | 103.5 | 75 | 388.0 | | | „ |
| 45 | 126.3 | 80 | 459.3 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 95°6 | EFTRING (1938) | 96°4 | NELSON and YOUNG (1933) |
| 96°25 | LECAT (passim) | | |

*Density* *Surface tension*

| t° | d | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 20 | 1.1545 | Nelson and Young (1933) | 20 | 29.42 | Eftring (1938) |
| 20 | 1.1559 | Eftring (1938) | 40 | 26.91 | „ |

*Refractive index*

| t° | Hα | Hβ | Hγ | |
|---|---|---|---|---|
| 20 | 1.43785 | 1.44593 | 1.45051 | Eftring (1938) |

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_v$) 3963.4 cal 15°/g | Eftring (1938) |

## *Iso*-PROPYLIDENE DICHLORIDE or 2,2-DICHLOROPROPANE

$CH_3—CCl_2—CH_3$

**Constants:** B.E. (1934)

*Boiling point*

| | | | | |
|---|---|---|---|---|
| 69°88<br>70°4 | Eftring (1938)<br>Lecat (passim) | 70°5 | $\frac{dt}{dp}$ | *(10 mm)*; 0°41 B.E. (1934) |

*Freezing point*

| | | | |
|---|---|---|---|
| −33°8 | Turkevich and Smyth (1940) | −34°4 | B.E. (1934) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.11921 | B.E. (1934) | 30 | 1.07767 | B.E. (1934) |
| 15 | 1.09843 | „ | 20 | 1.0912 | Eftring (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 769 | B.E. (1934) |
| 30 | 619 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 24.30 | B.E. (1934) | 20 | 24.07 | EFTRING (1938) |
| 20 | 23.62 | „ | 40 | 21.53 | „ |
| 30 | 22.53 | „ | | | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.41501 | 1.41538 | 1.41793 | 1.42241 | 1.42348 | 1.42718 | — | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 47 | 49 | 49 | 52 | — | „ |
| 20 | — | 1.41311 | — | — | 1.42097 | — | 1.42545 | EFTRING (1938) |

| *Heat of combustion* | 20° ($c_v$) 3955.4 cal 15°/g | EFTRING (1938) |
|---|---|---|

## TRIMETHYLENE DICHLORIDE or 1.3-DICHLOROPROPANE

$CH_2Cl—CH_2—CH_2Cl$

**Constants:** EFTRING (1938)

*Density*

| t° | d |
|---|---|
| 20 | 1.1862 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 20 | 34.01 |
| 40 | 31.44 |

*Refractive index*

| t° | Hα | Hβ | Hγ |
|---|---|---|---|
| 20 | 1.44692 | 1.45506 | 1.45973 |

| *Heat of combustion* | 20° ($c_v$) 3968.4 cal 15°/g |
|---|---|

## PROPYLENE DIBROMIDE or 1,2-DIBROMOPROPANE

$CH_3—CHBr—CH_2Br$

**Constants**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| 37.3 | 15 | 61.8 | 50 | KAHLBAUM and ARNDT (1898) |
| 42.5 | 20 | 71.4 | 75 | „ |
| 46.8 | 25 | 78.4 | 100 | „ |
| 50.6 | 30 | 89.2 | 150 | „ |
| 53.9 | 35 | 97.2 | 200 | „ |
| 56.8 | 40 | 103.8 | 250 | „ |
| 59.4 | 45 | 109.6 | 300 | „ |

*Boiling point*

| | |
|---|---|
| 140°5 | LECAT (passim) |
| 141°0 | KAHLBAUM and ARNDT (1898) |

*Freezing point*

| | |
|---|---|
| −55°35 | TIMMERMANS (passim) |

*Density*

| t° | d | |
|---|---|---|
| 20 | 1.93326 | KAHLBAUM and ARNDT (1898) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20° | 1.51659 | 1.51976 | 1.52966 | 1.53736 | KAHLBAUM and ARNDT (1898) |

## TRIMETHYLENE DIBROMIDE or 1,3-DIBROMOPROPANE

$CH_2Br—CH_2—CH_2Br$

**Constants:** SERWY (1933)

*Boiling point*

| | |
|---|---|
| 166°9 | LECAT (passim) |
| 167°34 | $\frac{dt}{dp}$ *(10 mm)*; 0°50 SERWY (1933) |

*Freezing point*

| | |
|---|---|
| −34°2 | SERWY (1933) |

*Density*

| t° | d |
|---|---|
| 0 | 2.01618 |
| 15 | 1.98927 |
| 30 | 1.96238 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 2241 |
| 30 | 1746 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.52121 | 1.52174 | 1.52546 | 1.53252 | 1.53416 | 1.53932 | 1.54464 |
| $\frac{dn}{dt}$ | 0.00048 | 48 | 48 | 49 | 48 | 50 | — |

## 1,2,3-TRICHLOROPROPANE $CH_2Cl—CHCl—CH_2Cl$

**Constants:** Eftring (1938)

*Boiling point:* 156°6

*Density*

| t° | d |
|---|---|
| 20 | 1.3896 |

*Refractive index*

| t° | Hα | D | Hβ | Hγ |
|---|---|---|---|---|
| 20 | 1.48129 | 1.4836 | 1.49031 | 1.49561 |

| | |
|---|---|
| *Heat of combustion* | 20° ($c_v$) 2788.4 cal 15°/g |

## 1,1,1,2,2,3,3-HEPTACHLOROPROPANE $CCl_3—CCl_2—CCl_2H$

*Saturated vapour pressure, boiling and freezing points and density:* Boeseken and Prins (1911) and Prins (1914)

# D. HALOGENATED DERIVATIVES OF BUTANE

## BUTYL FLUORIDES

**Constants:** DESREUX (1935)

| | *prim.* $n$-$C_3H_7$—$CH_2F$ | | *sec.* $C_2H_5$—$CHF$—$CH_3$ | |
|---|---|---|---|---|
| *Boiling point* | 32°48 | | 25°08 | |
| *Density* | t° | d | t° | d |
| | 0 | 0.8005 | 0 | 0.7884 |
| | 15 | 0.7824 | 15 | 0.7700 |
| | 20 | 0.7761 | | |
| *Viscosity* $\eta \cdot 10^5$ | 20 | $\eta$: 284.5 | 15 | $\eta$: 286.2 |
| *Surface tension* | 20 | $\gamma$: 17.72 | 15 | $\gamma$: 16.93 |
| *Refractive index* | 15 | n Hα 1.3404<br>D 1.3419<br>Hβ 1.3457<br>Hγ 1.3488 | 12 | n Hα 1.3350<br>D 1.3366<br>Hβ 1.3403 |

## $n$-BUTYL CHLORIDE $n$-$C_3H_7$—$CH_2Cl$

**Constants:** B.E. (1930)

*Boiling point*

| | | |
|---|---|---|
| 78°5 | $\frac{dt}{dp}$ *(10 mm)*; 0°42 LECAT (passim) | |
| 78°50 | „ 0°41 B.E. (1930) | |

*Freezing point*

| | |
|---|---|
| −123°1 | B.E. (1930) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.90838 | B.E. (1930) | 20 | 0.8866 | VOGEL (1943) |
| 15 | 0.89197 | „ | 40.9 | 0.8650 | „ |
| 30 | 0.87549 | „ | 60.6 | 0.8427 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 469 | B.E. (1930) |
| 30 | 405 | „ |

*Surface tension*

| t° | γ | | t° | γ | |
|---|---|---|---|---|---|
| 15 | 24.40 | B.E. (1928) | 19.0 | 23.85 | Vogel (1943) |
| 20 | 23.90 | „ | 26.3 | 23.10 | „ |
| 30 | 22.88 | „ | 41.0 | 21.25 | „ |
| | | | 61.6 | 19.14 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40237 | 1.40276 | — | 1.40499 | 1.40903 | 1.40978 | 1.41331 | 1.41436 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00050 | 50 | — | 51 | 52 | 53 | 54 | — | „ |
| 20 | — | 1.39940 | 1.40223 | — | — | 1.40730 | — | 1.41099 | Vogel (1943) |

## *Iso*-BUTYL CHLORIDE $(CH_3)_2CH—CH_2Cl$

**Constants:** B.E. (1926)

*Saturated vapour pressure:* 20° 126.2 mm Hirshberg (1932)

*Boiling point*

| | |
|---|---|
| 68°81 | Eftring (1938) |
| 68°85 | $\frac{dt}{dp}$ *(10 mm);* 0°42 B.E. (1926) and Lecat (passim) |

*Freezing point:* −131°2 B.E. (1926)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.89962 | B.E. (1926) | 30 | 0.86620 | B.E. (1926) |
| 15 | 0.88290 | „ | 20 | 0.8776 | Eftring (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 471 | B.E. (1926) |
| 30 | 395 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 22.56 | Hennaut-Roland and Lek (1931) |
| 20 | 21.99 | „ |
| 30 | 20.87 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.39829 | 1.39884 | 1.40096 | 1.40100 | 1.40496 | 1.40609 | 1.40902 | 1.41039 |
| $\frac{dn}{dt}$ | — | 0.00052 | 52 | 52 | — | 52 | — | 52 |

| *Heat of combustion* | 20° ($c_v$) 6929.8 cal 15°/g | Eftring (1938) |
|---|---|---|

## *Sec.*-BUTYL CHLORIDE $CH_3—CHCl—C_2H_5$

**Constants:** B.E. (1928)

*Saturated vapour pressure*

| t° | p mm | |
|---|---|---|
| 0.32 | 49.3 | Roland (1928) |
| 10.02 | 79.95 | „ |
| 20.18 | 127.5 | „ |

| t° | p mm | |
|---|---|---|
| 29.96 | 193.8 | Roland (1928) |
| 39.85 | 285.1 | „ |

*Boiling point*

| | | |
|---|---|---|
| 68°25 | $\frac{dt}{dp}$ *(10 mm)*; 0°41 | B.E. (1928) and Lecat (passim) |
| 68°25 | | Eftring (1938) |

*Freezing point*

| | |
|---|---|
| −131°3 | (racem.) B.E. (1928) |
| −140°0 | (active) „ |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.89556 | (rac) B.E. (1928) |
| 15 | 0.87880 | „ |
| 20 | 0.87323 | „ |

| t° | d | |
|---|---|---|
| 30 | 0.86210 | B.E. (1928) |
| 0 | 0.89497 | (active) „ |
| 20 | 0.8728 | Eftring (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 439 | B.E. (1928) |
| 30 | 363 | „ |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ |
|---|---|---|---|---|---|
| 15 | 1.3974 | 1.3994 | 1.39975 | 1.4045 | 1.4089 |
| $\frac{dn}{dt}$ | 0.00050 | 48 | — | 50 | 54 |

*Rotatory power*

| | | (α) | | | (n) |
|---|---|---|---|---|---|
| 20° Li | (red) | −6.40 | He y. | (yellow) | − 8.86 |
| Li | (or.) | −7.86 | He g. | (green) | −10.08 |
| Na | | −8.48 | Li | (blue) | −14.94 |
| | | | He g. | (violet) | −17.04 |

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_v$) 6924.8 cal 15°/g | EFTRING (1938) |

## *Tert.*-BUTYL CHLORIDE $(CH_3)_3CCl$

**Constants:** B.E. (1934)

*Boiling point*

| | | | |
|---|---|---|---|
| 50°7 | $\frac{dt}{dp}$ *(10 mm)*; 0°36 B.E. (1934) | 50°8 | $\frac{dt}{dp}$ *(10 mm)*; 0°37 LECAT (passim) |

*Freezing point*

| | |
|---|---|
| −27°1 | B.E. (1934) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.86523 | B.E. (1934) | 30 | 0.82936 | B.E. (1934) |
| 15 | 0.84739 | „ | | | |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 543 | | 15 | 20.06 | |
| 30 | 439 | | 20 | 19.56 | |
| | | | 30 | 18.35 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.38526 | 1.38557 | — | 1.38777 | 1.39188 | 1.39289 | 1.39620 | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00052 | 52 | — | 52 | 53 | 53 | 54 | „ |

## *n*-BUTYL BROMIDE $C_3H_7—CH_2Br$

**Constants:** B.E. (1926)

*Boiling point*

| | | | |
|---|---|---|---|
| 101°26 | Skau and Mac Cullough (1935) | 101°60 | B.E. (1926) |
| 101°5 | Lecat (passim) | 101°60 | Van Bogaert (1927) |
| 101°6 | Cupp and Rogers (1939) | | |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°50 | Lecat (passim) | 0°51 | B.E. (1926) |

*Freezing point*

| | | | |
|---|---|---|---|
| −112°3 | Skau and Mac Cullough (1935) | −112°4 | B.E. (1926) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.30435 | B.E. (1926) | 15 | 1.28284 | Skau and Mac Cullough (1935) |
| 15 | 1.28292 | „ | 25 | 1.2689 | Cupp and Rogers (1939) |
| 30 | 1.26120 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 666 | B.E. (unp.) (corr. val. 1926) | 20 | 633 | Mountford (unp.) |
| 30 | 567 | „ | 25 | 591.4 | Cupp and Rogers (1939) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 27.00 | Hennaut-Roland and Lek (1931) |
| 20 | 26.33 | „ |
| 30 | 25.21 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.43926 | 1.43940 | 1.44225 | 1.44241 | 1.44769 | 1.44875 | 1.45290 | 1.45410 | B.E. (1926) |
| $\frac{dn}{dt}$ | — | 0.00050 | 50 | 50 | — | 52 | — | 52 | „ |
| 25 | — | — | 1.4373 | — | — | — | — | — | Cupp and Rogers (1939) |

## *Iso*-BUTYL BROMIDE $(CH_3)_2CH—CH_2Br$

**Constants:** B.E. (1928)

*Boiling point:* 91°40 $\frac{dt}{dp}$ *(10 mm):* 0°37 B.E. (1928) and Lecat (passim)

*Freezing point:* −117°4 Timmermans (passim)

*Density*

| t° | d |
|---|---|
| 0 | 1.29410 |
| 15 | 1.27197 |
| 30 | 1.24980 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 679 |
| 30 | 567 |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ |
|---|---|---|---|---|---|
| 15 | 1.43639 | 1.43961 | 1.43914 | 1.44567 | 1.45131 |
| $\frac{dn}{dt}$ | 0.00049 | 50 | 50 | 50 | 52 |

## *Sec.*-BUTYL BROMIDE (rac. and antipodes) $CH_3—CHBr—C_2H_5$

**Constants:** B.E. (1934)

*Boiling point*

| | | | |
|---|---|---|---|
| 91°20 | $\frac{dt}{dp}$ *(10 mm)*; 0°51 B.E. (1934) and Lecat (passim) | 91°3 | Houston (1933) |
| 91°24 | Skau and Mac Cullough (1935) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −111°9 | B.E. (1934) | −112°1 | Skau and Mac Cullough (1935) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.28968 | B.E. (1934) | 25 | 1.2530 | Skau and Mac Cullough (1935) |
| 15 | 1.26808 | „ | | | |
| 30 | 1.24643 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 618 | B.E. (1934) |
| 30 | 526 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 25.85 | Hennaut-Roland and |
| 20 | 25.18 | „ Lek (1931) |
| 30 | 23.86 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.43619 | 1.43664 | 1.43950 | 1.44485 | 1.44614 | 1.45030 | 1.45199 |
| $\frac{dn}{dt}$ | 0.00046 | 46 | 48 | 49 | 49 | 49 | 51 |

## *Tert.*-BUTYL BROMIDE $(CH_3)_3CBr$

**Constants:** B.E. (1934)

*Boiling point:* 73°25 $\frac{dt}{dp}$ *(10 mm):* 0°40 B.E. (1934) and LECAT (passim)

*Freezing point:* −16°2 B.E. (1934)

*Density* / *Viscosity* / *Surface tension*

| t° | d | | t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|---|---|---|
| 0 | 1.25160 | | 15 | 883 | | 15 | 22.96 | |
| 15 | 1.22861 | | 30 | 702 | | 20 | 22.45 | |
| 30 | 1.20553 | | | | | 30 | 21.24 | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.42736 | 1.42782 | 1.43071 | 1.43634 | 1.43753 | 1.44205 |
| $\frac{dn}{dt}$ | 0.00051 | 51 | 52 | 53 | 52 | — |

## *n*-BUTYL IODIDE $C_3H_7—CH_2I$

**Constants:** B.E. (1934)

*Saturated vapour pressure:* MILAZZO (1944)

*Boiling point:* 130°40 $\frac{dt}{dp}$ *(10 mm):* 0°48 B.E. (1934) and LECAT (passim)

*Freezing point:* −103°0 B.E. (1934)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.64833 | B.E. (1934) | 20 | 1.6157 | VOGEL (1943) |
| 15 | 1.62366 | „ | 41.7 | 1.5815 | „ |
| 30 | 1.59890 | „ | 61.5 | 1.5492 | „ |
| | | | 85.8 | 1.5090 | „ |

*Viscosity* / *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 918 | B.E. (1934) | 15 | 29.78 | B.E. (1934) |
| 30 | 777 | „ | 20 | 29.15 | „ |
| | | | 30 | 27.90 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.49797 | 1.49850 | 1.50258 | 1.50277 | 1.51068 | 1.51266 | — | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00052 | 53 | 54 | 54 | 55 | 55 | — | „ |
| 20 | — | 1.49589 | 1.49984 | — | — | 1.50978 | 1.51769 | VOGEL (1943) |

## *Iso*-BUTYL IODIDE $(CH_3)_2CH—CH_2I$

**Constants:** B.E. (1934)

*Boiling point* *Freezing point*

| | | | |
|---|---|---|---|
| 120°8 | $\frac{dt}{dp}$ *(10 mm)*; 0°49 LECAT (passim) | −93°5 | B.E. (1934) |
| 121°00 | „ 0°48 B.E. (1934) | | |

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ |
|---|---|---|---|---|---|
| 0 | 1.63682 | 15 | 945 | 15 | 28.52 |
| 15 | 1.61176 | 30 | 777 | 20 | 27.97 |
| 30 | 1.58693 | | | 30 | 27.04 |

*Refractive index*

| t° | He r. | Hα | He y. | He v. | Hβ |
|---|---|---|---|---|---|
| 15 | 1.49429 | 1.49483 | 1.49897 | 1.50698 | 1.50888 |
| $\frac{dn}{dt}$ | 0.00049 | 49 | 49 | 49 | 50 |

## *Sec*-BUTYL IODIDE $CH_3—CHI—C_2H_5$

**Constants:** B.E. (1934)

*Boiling point:* 120°00 $\frac{dt}{dp}$ *(10 mm):* 0°48 B.E. (1934) and LECAT (passim)

*Freezing point:* −104°0 B.E. (1934)

*Density*

| t° | d |
|---|---|
| 0 | 1.63055 |
| 15 | 1.60584 |
| 30 | 1.58099 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 885 |
| 30 | 725 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 28.60 |
| 20 | 28.34 |
| 30 | 27.85 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.49770 | 1.49846 | 1.50265 | 1.50269 | 1.51104 | 1.51314 | 1.51960 | 1.52200 |
| $\frac{dn}{dt}$ | 0.00050 | 50 | 51 | 51 | 52 | 52 | — | — |

VOGEL (1943) has studied a series of monochloro-, monobromo-, and monoiodo derivatives from $C_4$ to $C_{12}$. His constants can not be retained, because they do not agree with those given by most of the other authors.

# E. HALOGENATED DERIVATIVES OF THE HIGHER HOMOLOGOUS PARAFFINS

## *n*-AMYL FLUORIDE $C_4H_9—CH_2F$

**Constants:** SWARTS (1931)

*Boiling point:* 62°8 SWARTS (1931)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 10.5 | 0.7960 | Swarts (1931) | 20 | 0.7905 | Desreux (1935) |
| 26 | 0.7880 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 20 | 372.0 | Swarts (1931) | 50 | 277.5 | Swarts (1931) |
| 30 | 335 | „ | 60 | 252.5 | „ |
| 40 | 303.5 | „ | | | |

*Surface tension:* 20° 20.06 Desreux (1935)

*Refractive index:* 26° Hα: 1.35622 Hβ: 1.36183 Hγ: 1.36533 Swarts (1931)

The other halogenated derivatives of *n*-amylalcohol have not been studied with accuracy.

## *Iso*-AMYL BROMIDE $(CH_3)_2CH—(CH_2)_2Br$

**Constants:** Timmermans and Hennaut-Roland (1929)

*Boiling point*

| | |
|---|---|
| 120°6 | Grimm and Patrick (1923) |
| 120°65 | $\frac{dt}{dp}$ *(10 mm);* 0°40 Timmermans and Hennaut-Roland (1929) and Lecat (passim) |

*Freezing point:* — 111°9

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.22912 | |
| 15 | 1.20950 | |
| 30 | 1.18989 | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 792 | |
| 30 | 652 | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 26.40 | |
| 20 | 25.86 | |
| 30 | 24.79 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.43996 | 1.44067 | 1.44332 | 1.44337 | 1.44828 | 1.44956 | 1.45351 | 1.45531 |
| $\frac{dn}{dt}$ | — | — | 0.00049 | 50 | — | 49 | — | 51 |

*Dielectric constant:* 18° 6.1 GRIMM and PATRICK (1923)

2-FLUORO-, 2-CHLORO-, 2-BROMO- and 2-IODOPENTANES: $CH_3—CHR—(CH_2)_2—CH_3$ (R = F —Cl—Br—I)

*Saturated vapour pressure, density, refractive index* and *specific rotatory power;* BRAUNS, 1943.

UNDECA and PERFLUORO *n*-and *iso*-PENTANE $C_5F_{11}H$ and $C_5F_{12}$

*Refractive index* and *surface tension:* ROHRBACK and CADY (1949).

PENTAMETHYLENE DIBROMIDE $CH_2Br—(CH_2)_3—CH_2Br$

SERWY (1933) and JOHNSON (1933) studied the constants of this product, but their results do not agree.

| *n*-HEXYL FLUORIDE $C_5H_{11}—CH_2F$ | | *sec.*-HEXYL FLUORIDE or 2-FLUOROHEXANE $CH_3—CHF—C_4H_9$ | |
|---|---|---|---|
| **Constants:** DESREUX (1935) | | | |
| *Boiling point:* 93°37 | | 86°25 | |
| *Density* | | | |
| t° | d | t° | d |
| 0 | 0.8200 | 0 | 0.8185 |
| 15 | 0.8052 | 20 | 0.7916 |
| 20 | 0.8002 | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|---|---|
| 20 | 487.5 | 40 | 389.4 | 20 | 435.1 |
| 30 | 434.5 | 60 | 319.2 | | |

| | | | |
|---|---|---|---|
| *Surface tension:* | 20° 21.83 | — | |
| *Refractive index:* | 20° | 20°39 | |
| Hα | 1.3730 | 1.3677 | |
| D | 1.3748 | 1.3693 | |
| Hβ | 1.3791 | 1.3736 | |
| Hγ | 1.3826 | 1.3771 | |

## *n*-HEPTYL FLUORIDE $C_6H_{13}—CH_2F$

### Constants

*Boiling point:* 119°7
*Melting point:* −73°0
*Density:* 21° 0.80290 SWARTS (1919–21)

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 20 | 626 | SWARTS (1931) | 50 | 441 | SWARTS (1931) |
| 30.04 | 553 | „ | 61 | 396 | „ |
| 40.1 | 491.0 | „ | | | |

*Surface tension:* 20° 23.20 DESREUX (1935)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 21 | 1.38358 | 1.38550 | 1.38993 | 1.39358 | SWARTS (1921–23) |

## *n*-HEPTYL PERFLUORIDE $C_7F_{16}$

*Critical constants, saturated vapour pressure, boiling point, density, surface tension* and *refractive index:* FOWLER, HAMILTON JR., KASPER, WEBER, BURFORD and ANDERSON (1947).

*Refractive index* and *surface tension:* ROHRBACK and CADY (1949).

## *n*-HEPTYL CHLORIDES and *n*-HEPTYL BROMIDES

$CH_3—(CH_2)_5—CH_2Cl$; $CH_3—CHCl—(CH_2)_4—CH_3$; $C_2H_5—CHCl—(CH_2)_3—CH_3$;
$CH_3—(CH_2)_2—CHCl—(CH_2)_2—CH_3$; $CH_3—CHBr—(CH_2)_4—CH_3$;
$C_2H_5—CHBr—(CH_2)_3—CH_3$; $CH_3—(CH_2)_2—CHBr—(CH_2)_2—CH_3$

*Melting point, density, refractive index* and *dielectric constant;* SHERILL (1930) and ERRERA and SHERRILL (1930).

| *n*-HEPTYL BROMIDE $C_6H_{13}—CH_2Br$ | *n*-HEPTYL IODIDE $C_6H_{13}—CH_2I$ |
|---|---|

**Constants:** DEFFET (1931)

| | | |
|---|---|---|
| *Boiling point:* | 180°0 | 203°95 |
| *Melting point:* | —58°1 | —48°2 |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.16134 | DEFFET (1931) | 0 | 1.40339 | DEFFET (1931) |
| 15 | 1.14526 | „ | 15 | 1.38509 | „ |
| 30 | 0.12909 | „ | 30 | 1.36677 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 1432 | DEFFET (1931) | 15 | 1936 | DEFFET (1931) |
| 30 | 1117 | „ | 30 | 1498 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 29.00 | DEFFET (1931) | 15 | 30.88 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 28.56 | „ | 20 | 30.38 | |
| 30 | 27.50 | „ | 30 | 29.53 | „ |

*Refractive index*

| t° | 15 | $\frac{dn}{dt}$ | 15 | $\frac{dn}{dt}$ | |
|---|---|---|---|---|---|
| He r. | 1.44952 | 0.00043 | 1.48887 | 0.00045 | DEFFET (1931) |
| H$\alpha$ | 1.44982 | 42 | 1.48924 | 45 | „ |
| He y. | 1.45260 | 43 | 1.49297 | 46 | „ |
| He g. | 1.45774 | 43 | 1.49998 | 46 | „ |
| H$\beta$ | 1.45894 | 43 | 1.50151 | 47 | „ |
| He v. | 1.46248 | 44 | 1.50647 | 49 | „ |
| H$\gamma$ | 1.46397 | 44 | 1.50812 | — | |

| | *n*-OCTYL FLUORIDE $n\text{-}C_7H_{15}—CH_2F$ | | *n*-OCTYL BROMIDE $n\text{-}C_7H_{15}—CH_2Br$ | | *n*-OCTYL IODIDE $n\text{-}C_7H_{15}—CH_2I$ | |
|---|---|---|---|---|---|---|
| **Constants** | SWARTS (1919–23) | | DEFFET (1931) | | DEFFET (1931) | |
| *Boiling point* | 142°8 | | 201°5 | | 225°55 | |
| $\frac{dt}{dp}$ *(10 mm)* | — | | 0°55 | | 0°60 | |
| | — | | — | | 225°5 DOBRINER (1888) | |
| *Melting point* | — | | −55°0 | | −45°7 | |
| *Density* | t° | d | t° | d | t° | d |
| | 14.1 | 0.8120 | 0 | 1.13312 | 0 | 1.35312 |
| | 21 | 0.80361 | 15 | 1.11795 | 15 | 1.33568 |
| | | | 30 | 1.10269 | 30 | 1.31820 |
| *Viscosity* | | | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
| | — | | 15 | 1791 | 15 | 2408 |
| | | | 30 | 1382 | 30 | 1796 |
| *Surface tension* | | | t° | $\gamma$ | | |
| | — | | 15 | 29.54 | — | |
| | | | 20 | 28.89 | | |
| | | | 30 | 27.67 | | |
| | | | HENNAUT-ROLAND and LEK (1931) | | | |
| *Refractive index* t° | 14°1 | | 15° | $\frac{dn}{dt}$ | 15° | $\frac{dn}{dt}$ |
| Her. | — | | 1.45173 | 0.00041 | 1.48681 | 0.00043 |
| Hα | 1.39520 | | 1.45216 | 41 | 1.48729 | 43 |
| D | 1.39703 | | — | — | — | — |
| He y. | — | | 1.45489 | 41 | 1.49084 | 43 |
| He g. | — | | 1.46002 | 41 | 1.49746 | 44 |
| Hβ | 1.40175 | | 1.46126 | 41 | 1.49913 | 45 |
| He v. | — | | 1.46487 | 41 | 1.50397 | 46 |
| Hγ | 1.40565 | | 1.46640 | 41 | 1.50608 | — |

## 2-CHLORO-2,3,3-TRIMETHYLPENTANE $CH_3\text{-}CCl(CH_3)\text{-}C(CH_3)_2\text{-}CH_2\text{-}CH_3$

**Constants:** HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947)

| | | | |
|---|---|---|---|
| *Freezing point* | +10°6 | *Refractive index* | $n_D^{20°}$ 1.4457 $\frac{dn}{dt}$ 0.00042 |
| *Density:* | 20° 0.9105 | | $n_D^{25°}$ 1.4436 |
| | 25° 0.9065 | | |

TRIALKYLCHLOROMETHANES: *Density* and *surface tension:* SMART and QUAYLE (1945)

# F. HALOGENATED DERIVATIVES OF UNSATURATED ALIPHATIC HYDROCARBONS

## VINYL CHLORIDE or MONOCHLOROETHYLENE $CH_2=CHCl$

*Saturated vapour pressure:* Roslovska and Temkin (1946)

| t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|
| 10 | 2.51 | 40 | 5.76 | 70 | 11.23 |
| 20 | 3.39 | 50 | 7.24 | | |
| 30 | 4.60 | 60 | 9.12 | | |

## VINYL BROMIDE or MONOBROMOETHYLENE $CH_2=CHBr$

### Constants

*Saturated vapour pressure:* Mehl (1934)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −66 | 9.5 | −21.0 | 150.2 | 7.8 | 560.9 |
| −53.5 | 23.2 | −10.5 | 248.9 | 10.0 | 610.5 |
| −43.0 | 44.1 | 0.0 | 402.1 | 11.9 | 657.4 |
| −29.5 | 97.0 | 5.2 | 501.0 | | |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 15°60 | Mehl (1934) | −137°8 | Timmermans (passim) |
| 15°8 | Lecat (passim) | | |
| 15°80 | Timmermans (1913) | | |

## VINYLIDENE CHLORIDE or 1.1-DICHLOROETHYLENE $CH_2=CCl_2$

*Saturated vapour pressure:* Roslovska and Temkin (1946)

| t° | p atm. | t° | p atm. | t° | p atm. | |
|---|---|---|---|---|---|---|
| 10 | 0.39 | 40 | 1.21 | 70 | 3.09 | (The authors give somewhat higher |
| 20 | 0.59 | 50 | 1.69 | 80 | 4.07 | values for another sample |
| 30 | 0.85 | 60 | 2.30 | | | |

# 1,2-DICHLOROETHYLENES $(CHCl)_2$

## Constants

*Saturated vapour pressure*

| *Trans* t° | p mm | *Cis* t° | p mm | |
|---|---|---|---|---|
| −38.19 | 10.4 | −33.00 | 9.3 | Ketelaar, Van Velden and |
| −30.14 | 20.4 | −12.35 | 32.3 | „ Zalm (1947) |
| −28.30 | 22.5 | − 6.23 | 44.9 | „ |
| −19.19 | 41.2 | + 0.76 | 64.7 | „ |
| −15.12 | 50.5 | 30.06 | 250.4 | „ |
| − 7.29 | 75.7 | 77.40 | 1286.4 | „ |
| + 0.52 | 113.0 | 99.03 | 2304.7 | „ |
| 16.91 | 237.4 | | | „ |
| 39.52 | 571.9 | | | „ |
| 56.12 | 1000.5 | | | „ |
| 84.84 | 2284.4 | | | (other temperatures by authors) |

*Boiling point*

47°66 Eftring (1938)
47°7 Ketelaar, Van Velden and Zalm (1947)

60°25 Chavanne (1912)
60°27 Eftring (1938)
60°5 Ketelaar, Van Velden and Zalm (1947)

*Freezing point* —

−80°5 Timmermans

*Density*

| | | |
|---|---|---|
| 15° | — | |
| 20° | 1.2546 | 1.2913 Chavanne (1912) |
| 15° | 1.2631 | 1.2818 Eftring (1938) |
| | | 1.2917 Ketelaar, De Vries, Van Velden and Kooij (1947) |
| 20° | 1.2547 | 1.2837 „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|---|---|
| −50 | 1005 | −10 | 560 | −65 | 1538 | −15 | 690 | Ketelaar, De Vries, Van Velden and Kooij |
| −45 | 925 | − 5 | 526 | −60 | 1393 | −10 | 647 | „ (1947) |
| −40 | 847 | 0 | 498 | −55 | 1271 | − 5 | 609 | „ |
| −35 | 783 | + 5 | 471 | −50 | 1156 | 0 | 577 | „ |
| −30 | 729 | 10 | 447 | −45 | 1057 | + 5 | 546 | „ |
| −25 | 682 | 15 | 423 | −40 | 973 | 10 | 516 | „ |
| −20 | 637 | 20 | 404 | −35 | 904 | 15 | 490 | „ |
| −15 | 597 | | | −30 | 843 | 20 | 467 | „ |
| | | | | −25 | 791 | 25 | 444 | „ |
| | | | | −20 | 738 | | | „ |

## 1,2-DICHLOROETHYLENES (continued)

| | *Trans* | | | *Cis* | | | |
|---|---|---|---|---|---|---|---|
| *Surface tension* | 20° | 25 | | 28 | Ketelaar, De Vries, Van Velden and Kooij (1947) | | |
| *Refractive index* | | | | | | | |
| t° | Hα | D | Hβ | Hα | D | Hβ | |
| 10.4 | 1.44849 | — | 1.46002 | 1.45139 | — | — | Chavanne(1912) |
| 15 | 1.44556 | 1.44903 | 1.45715 | 1.44868 | 1.45189 | 1.45981 | ,, |
| $\frac{dn}{dt}$ | 0.00063 | — | 0.00062 | 0.00059 | — | — | ,, |
| 20 | — | 1.4462 | — | — | 1.4490 | — | Eftring (1938) |
| *Dielectric constant* | 25° | 2.145 | | 9.31 | Ketelaar, Van Velden and Zalm (1947) | | |
| *Heat of combustion* ($c_v$) cal 15°/g | 20° | 2682.5 | | 2688.5 | Eftring (1938) | | |

## 1,2-DIIODOETHYLENE *(Trans)* $(CHI)_2$

Prepared by the method of Chavanne and Vos (1914), which consists in passing anhydrous acetylene over iodine. The sample has a melting point of 72°.

*Saturated vapour pressure:* Broadway and Fraser (1933).

## TETRACHLOROETHYLENE $C_2Cl_4$

Stabilisation by thymol (Bailey, 1939)

**Constants:** B.E. (1930)

*Boiling point:* 121°0 $\frac{dt}{dp}$ *(10 mm):* 0°50 Lecat (passim)

121°20 ,, 0°50 B.E. (1930)

*Freezing point:* −22°35 B.E. (1930)

*Density*

| t° | d |
|---|---|
| 0 | 1.65582 |
| 15 | 1.63109 |
| 30 | 1.60640 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 932 |
| 30 | 798 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 32.86 |
| 20 | 32.32 |
| 30 | 31.27 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.50289 | 1.50348 | 1.50759 | 1.51537 | 1.51723 | 1.52334 |
| $\frac{dn}{dt}$ | 0.00051 | 53 | 53 | 53 | 53 | 52 |

## TRIFLUOROMONOCHLOROETHYLENE $C_2F_3Cl$

### Constants

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 107.0 | 39.0 | Booth and Swinehart (1935) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −78.56 | 45.2 | −26.46 | 815.0 | Booth, Burchfield, Bixby and Mac Kelvey (1933) |
| −33.56 | 593.4 | −25.36 | 853.7 | |
| −28.46 | 742.1 | −23.46 | 920.7 | ,, |
| −27.76 | 767.3 | | | ,, |

| t° | p atm. | t° | p atm. | |
|---|---|---|---|---|
| 21.9 | 5.7 | 81.2 | 24.6 | Booth and Swinehart (1935) |
| 33.8 | 8.0 | 91.3 | 28.2 | ,, |
| 40.3 | 9.9 | 100.8 | 35.1 | ,, |
| 60.3 | 15.5 | 101.7 | 35.4 | ,, |
| 72.3 | 19.1 | 104.3 | 37.1 | ,, |

*Boiling point:* —27°9 Booth, Burchfield, Bixby and Mac Kelvey (1933)

*Freezing point:* —157°5 ,,

## ALLYL CHLORIDE $CH_3CH=CHCl$

**Constants:** B.E. (1932)

*Boiling point:* 45°10 $\frac{dt}{dp}$ *(10 mm):* 0°.42 B.E. (1932)

45°15 Lecat (passim)

*Freezing point:* —134°5 B.E. (1932)

*Density*

| t° | d |
|---|---|
| 0 | 0.96374 |
| 15 | 0.94419 |
| 30 | 0.92454 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 347 |
| 30 | 300 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 28.85 |
| 20 | 23.06 |
| 30 | 21.83 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.41534 | 1.41582 | 1.41887 | 1.42462 | 1.42597 | 1.43056 | 1.43225 |
| $\frac{dn}{dt}$ | 0.00068 | 69 | 69 | 72 | 74 | 74 | 75 |

1,3-DICHLOROPROPENES: *boiling point, density* and *refractive index*: Hatch and Perry Jr. (1949).

# G. HALOGENATED DERIVATIVES OF THE AROMATIC SERIES

## Derivatives of Benzene

### FLUOROBENZENE $C_6H_5F$

**Constants:** B.E. (1935)

*Boiling point:* 84°75 Morre and Hobbs (1949)

84°85 $\frac{dt}{dp}$ *(10 mm):* 0°40 B.E. (1935)

84°9 Lecat (passim)

*Freezing point:* −41°9 B.E. (1935)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.04863 | B.E. (1935) | 30 | 1.01314 | B.E. (1935) |
| 15 | 1.03091 | „ | 20 | 1.0252 | Desreux (1935) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 620 | B.E. (1935) | 19.95 | 582.2 | Swarts (1931) |
| 30 | 517 | „ | 30 | 516.4 | „ |
| | | | 39.95 | 460 | „ |
| | | | 50 | 414.7 | „ |
| | | | 60.04 | 375 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 28.41 | B.E. (1935) | 20 | 27.71 | Desreux (1935) |
| 20 | 27.78 | „ | | | |
| 30 | 26.47 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.46338 | 1.46412 | 1.46837 | 1.46853 | 1.47653 | 1.47865 | 1.48522 |
| $\frac{dn}{dt}$ | 0.00049 | 49 | — | 50 | 50 | 50 | 50 |

**Heat constants:** STULL (1937)

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −183.16 | 0.1171 | −103.16 | 0.2087 | −23.16 | 0.3477 |
| −173.16 | 0.1275 | − 93.16 | 0.2216 | −13.16 | 0.3533 |
| −163.16 | 0.1385 | − 83.16 | 0.2348 | − 3.16 | 0.3578 |
| −153.16 | 0.1499 | − 73.16 | 0.2477 | + 6.84 | 0.3608 |
| −143.16 | 0.1608 | − 63.16 | 0.2609 | +16.84 | 0.3548 |
| −133.16 | 0.1730 | − 53.16 | 0.2745 | +26.84 | 0.3652 |
| −123.16 | 0.1842 | − 43.16 | 0.2878 | +36.84 | 0.3676 |
| −113.16 | 0.1971 | L. − 33.16 | 0.3402 | +46.84 | 0.3735 |

| | |
|---|---|
| *Heat of melting* | 25.885 cal 15°/g |

## CHLOROBENZENE $C_6H_5Cl$

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Densities of the liquid and of the saturated vapour*

| t° | L. | t° | L. | V. | |
|---|---|---|---|---|---|
| 0 | 1.12786 | 150 | 0.9599 | — | YOUNG (1910) |
| 10 | 1.1171 | 160 | 0.9480 | — | ,, |
| 20 | 1.1062 | 170 | 0.9354 | 0.008375 | ,, |
| 30 | 1.0954 | 180 | 0.9224 | 0.01023 | ,, |
| 40 | 1.0846 | 190 | 0.9091 | 0.01247 | ,, |
| 50 | 1.0742 | 200 | 0.8955 | 0.01506 | ,, |
| 60 | 1.0636 | 210 | 0.8815 | 0.01808 | ,, |
| 70 | 1.0526 | 220 | 0.8672 | 0.02145 | ,, |
| 80 | 1.0419 | 230 | 0.8518 | 0.02544 | ,, |
| 90 | 1.0305 | 240 | 0.8356 | 0.03000 | ,, |
| 100 | 1.0189 | 250 | 0.8196 | 0.03540 | ,, |
| 110 | 1.0079 | 260 | 0.8016 | 0.04172 | ,, |
| 120 | 0.9960 | 270 | 0.7834 | 0.04921 | ,, |
| 130 | 0.9836 | 329.2 | 0.6411 | — | ,, |
| 140 | 0.9723 | 358.8 | 0.4400 | — | ,, |

*Rectilinear diameter:* $0.5640 - 5337 \cdot 10^{-7}\ t° - 509 \cdot 10^{-10}\ t°^2$ YOUNG (1910); RAMSAY and YOUNG (1887)

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 359.2 | 33926 | 0.3654 | YOUNG (1909–10) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −15.1 | 0.913 | −30.1 | 0.267 | −35.1 | 0.176 | MÜNDEL (1913) |
| −25.1 | 0.410 | | | | | „ |
| 70 | 99.3 | | | | | MARTIN and COLLIE (1932) |
| 0 | 2.52 | 100 | 292.75 | 200 | 3521 | YOUNG (1910) |
| 10 | 4.86 | 110 | 402.55 | 210 | 4229 | „ |
| 20 | 8.76 | 120 | 542.80 | 220 | 5056 | „ |
| 30 | 15.45 | 130 | 718.95 | 230 | 5989 | „ |
| 40 | 26.00 | 140 | 939.4 | 240 | 7080 | „ |
| 50 | 41.98 | 150 | 1206 | 250 | 8270 | „ |
| 60 | 65.54 | 160 | 1534 | 260 | 9647 | „ |
| 70 | 97.90 | 170 | 1920 | 270 | 11188 | „ |
| 80 | 144.75 | 180 | 2370 | 329.2 | 23935 | „ |
| 90 | 208.35 | 190 | 2902 | 358.8 | 33824 | „ |
| 99.231 | 289.1 | 131.687 | 760.00 | 165.309 | 1741.0 | ZMACZYNSKI (1930) |
| 105.629 | 355.1 | 138.318 | 906.1 | 172.173 | 2026.3 | „ |
| 112.074 | 433.9 | 144.996 | 1074.6 | 179.084 | 2347.4 | „ |
| 118.565 | 525.76 | 151.720 | 1268.1 | | | „ |
| 125.103 | 633.90 | 158.491 | 1489.2 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 131°687 | $\frac{dt}{dp}$ *(10 mm)*: 0°488 ZMACZYNSKI (1930) | 132°00 | $\frac{dt}{dp}$ *(10 mm)*: 0°49 B.E. (1926) (YOUNG's value (1902) taken as standard). |
| 131°75 | „ 0°51 LECAT (passim) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −45°1 | B.E. (1926) | −45°21 | STULL (1937) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.12792 | B.E. (1926) | 0 | 1.12795 | Young (1910) |
| 15 | 1.11172 | „ | 10 | 1.1171 | „ |
| 30 | 1.09550 | „ | 20 | 1.1062 | „ |
| | | | 30 | 1.09550 | „ |
| 0 | 1.12792 | Biron (1910) | | | |
| 20 | 1.10643 | „ | | | |
| 40 | 1.0848 | „ | | | |
| 9.7 | 1.1172 | Meyer and Mylius (1920) | 80.4 | 1.0415 | Meyer and Mylius |
| 10 | 1.1169 | „ | 83.3 | 1.0385 | „ (1920) |
| 17.6 | 1.1090 | „ | 88.1 | 1.0330 | „ |
| 20.1 | 1.1060 | „ | 96.2 | 1.0235 | „ |
| 25.1 | 1.1010 | „ | 102.2 | 1.0170 | „ |
| 30.2 | 1.0950 | „ | 107.8 | 1.0100 | „ |
| 35.0 | 1.0901 | „ | 113.1 | 1.0040 | „ |
| 55 | 1.0690 | „ | 119.6 | 0.9962 | „ |
| 60 | 1.0640 | „ | 123.6 | 0.9915 | „ |
| 63.7 | 1.0600 | „ | | | |
| 15 | 1.11150 | Perkin (1896) | −45.0 | 1.17713 | Timmermans (1912) |
| 20 | 1.1063 | „ | −35.3 | 1.16630 | „ |
| 30 | 1.0957 | „ | −30.6 | 1.16103 | „ |
| 45 | 1.0794 | „ | −22.95 | 1.15253 | „ |
| 50 | 1.0740 | „ | −13.1 | 1.14201 | „ |
| | | | − 6.2 | 1.13452 | „ |
| 24.12 | 1.10215 | Patterson and Mac Donald (1908) | 0 | 1.12795 | „ |
| 38.53 | 1.08650 | „ | | | |
| 28 | 1.0978 | Velasco (1927) | 72.1 | 1.0505 | Velasco (1927) |
| 30.1 | 1.0955 | „ | 75.1 | 1.0470 | „ |
| 46.1 | 1.0783 | „ | 80.8 | 1.0404 | „ |
| 47.9 | 1.0763 | „ | 94.8 | 1.0251 | „ |
| 64.1 | 1.0587 | „ | 108.6 | 1.0100 | „ |
| 66.4 | 1.0562 | „ | | | |
| 0 | 1.12780 | Tyrer (1914) | 25 | 1.1010 | Coates and Coates (1944) |
| 20 | 1.1061 | Bramley (1916) | | | |
| 20 | 1.10617 | Zmaczynski (1930) | 25 | 1.10110 | Gibson and Loeffler (1939) |
| 25 | 1.10085 | Le Fevre and Le Fevre (1936) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 20.1 | 803 | MEYER and MYLIUS (1920) | 15 | 844 | B.E. (1926) |
| 25.1 | 755 | „ | 30 | 711 | „ |
| 30.2 | 710 | „ | 20 | 794 | DEZELIC (1937) |
| 35.0 | 678 | „ | 25 | 758 | DUNSTAN, HILDITCH and THOLE (1913) |
| 35.2 | 672 | „ | | | |

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|---|---|
| 12.5 | 876 | 70.0 | 472 | 130.0 | 292 | 180.0 | 209 | TITANI (1927) |
| 20.0 | 799 | 80.0 | 431 | 131.7 | 287 | 190.0 | 196 | „ |
| 30.0 | 715 | 90.0 | 397 | 140.0 | 273 | 200.0 | 186 | „ |
| 40.0 | 631 | 100.0 | 367 | 150.0 | 257 | 210.0 | 173 | „ |
| 50.0 | 571 | 110.0 | 339 | 160.0 | 239 | 220.0 | 162 | „ |
| 60.0 | 512 | 120.0 | 313 | 170.0 | 222 | 230.0 | 155 | „ |
| | | | | | | 240.0 | 144 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 33.86 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 33.28 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.52172 | 1.52242 | 1.52748 | 1.52749 | 1.53725 | 1.53965 | 1.54735 | B.E. (1926) |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 54 | 55 | 55 | 55 | 55 | „ |
| 8.9 | — | 1.52579 | 1.53058 | — | — | — | — | HINSTEDT and WERTHEIMER (1922) |
| 20 | — | — | 1.52460 | — | — | — | — | DAVIES (1936) |
| 25 | — | 1.51697 | — | — | — | — | — | MARTIN and COLLIE (1932) |
| 5.5 | 1.52678 | — | — | 1.53251 | 1.54244 | — | 1.55254 | KALFF (1924) |
| 33.75 | 1.51166 | — | — | 1.51723 | 1.52685 | — | 1.53668 | „ |
| 64.0 | 1.49535 | — | — | 1.50074 | 1.51001 | — | 1.51953 | „ |
| 90.86 | 1.48045 | — | — | 1.48566 | 1.49467 | — | 1.50388 | „ |
| 107.6 | 1.47136 | — | — | 1.47643 | 1.48534 | — | 1.49427 | „ |

KALFF also gives values of the refractive index for other wavelengths. His compound was pure but the densities are affected by a systematic error.

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 21 | 5.670 | Le Fevre (1938) | 70 | 4.886 | Le Fevre (1938) |
| 40 | 5.372 | „ | 80 | 4.768 | „ |
| 48 | 5.227 | „ | 96.2 | 4.521 | „ |
| 20 | 5.6493 | Piette (1947) | 106 | 4.435 | „ |
| | | | 115 | 4.314 | „ |
| | | | 124 | 4.214 | „ |
| | | | 131 | 4.144 | „ |

**Heat constants**

*Specific heat:* Stull (1937)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −183.16 | 0.1067 | −123.16 | 0.1684 | −63.16 | 0.2201 | − 3.16 | 0.3152 |
| −173.16 | 0.1179 | −113.16 | 0.1769 | −53.16 | 0.2324 | + 6.84 | 0.3167 |
| −163.16 | 0.1298 | −103.16 | 0.1843 | −43.16 | 0.2916 | 16.84 | 0.3179 |
| −153.16 | 0.1394 | − 93.16 | 0.1915 | −33.16 | 0.3022 | 26.84 | 0.3191 |
| −143.16 | 0.1495 | − 83.16 | 0.1993 | −23.16 | 0.3091 | 36.84 | 0.3216 |
| −133.16 | 0.1590 | − 73.16 | 0.2087 | −13.16 | 0.3130 | 46.84 | 0.3269 |

| | | |
|---|---|---|
| *Heat of melting* | 20.491 cal 15°/g | Stull (1937) |

## BROMOBENZENE $C_6H_5Br$

**Constants:** B.E. (1926). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 397 | 33912 | 0.4853 | Young (1909–10) |

*Densities of the liquid and of the saturated vapour*

| t° | L. | t° | L. | V. | |
|---|---|---|---|---|---|
| 0 | 1.52182 | 140 | 1.3293 | — | YOUNG (1909–10) |
| 10 | 1.5083 | 150 | 1.3146 | 0.004125 | „ |
| 20 | 1.4948 | 160 | 1.2994 | 0.005241 | „ |
| 30 | 1.4815 | 170 | 1.2847 | 0.006562 | „ |
| 40 | 1.4682 | 180 | 1.2697 | 0.008117 | „ |
| 50 | 1.4546 | 190 | 1.2534 | 0.009950 | „ |
| 60 | 1.4411 | 200 | 1.2385 | 0.01209 | „ |
| 70 | 1.4272 | 210 | 1.2210 | 0.01458 | „ |
| 80 | 1.4142 | 220 | 1.2037 | 0.01745 | „ |
| 90 | 1.4006 | 230 | 1.1876 | 0.02079 | „ |
| 100 | 1.3864 | 240 | 1.1689 | 0.02482 | „ |
| 110 | 1.3729 | 250 | 1.1510 | 0.02927 | „ |
| 120 | 1.3583 | 260 | 1.1310 | 0.03427 | „ |
| 130 | 1.3439 | 270 | 1.1099 | 0.04016 | „ |

*Rectilinear diameter:* $0.7609 - 6655 \cdot 10^{-7}\, t° - 725 \cdot 10^{-10}\, t°^2$ YOUNG (1909–1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 120 | 274.9 | 130 | 372.65 | 140 | 495.8 | 150 | 649.05 | RAMSAY and YOUNG |
| 121 | 283.65 | 131 | 383.85 | 141 | 509.7 | 151 | 666.25 | „ (1887) |
| 122 | 292.6 | 132 | 395.1 | 142 | 523.9 | 151 | 683.8 | „ |
| 123 | 301.75 | 133 | 406.7 | 143 | 538.4 | 153 | 701.65 | „ |
| 124 | 311.15 | 134 | 418.6 | 144 | 553.2 | 154 | 719.95 | „ |
| 125 | 320.8 | 135 | 430.75 | 145 | 568.35 | 155 | 738.55 | „ |
| 126 | 330.7 | 136 | 443.2 | 146 | 583.85 | 156 | 757.55 | „ |
| 127 | 340.8 | 137 | 455.9 | 147 | 599.65 | 157 | 776.95 | „ |
| 128 | 351.15 | 138 | 468.9 | 148 | 615.75 | | | „ |
| 129 | 361.8 | 139 | 482.2 | 149 | 632.25 | | | „ |

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 121.588 | 289.1 | 148.944 | 633.90 | 184.261 | 1489.2 | ZMACZYNSKI (1930) |
| 128.352 | 355.1 | 162.921 | 906.1 | 191.474 | 1741.0 | „ |
| 135.166 | 433.6 | 169.985 | 1074.6 | 198.737 | 2026.3 | „ |
| 142.030 | 525.76 | 177.098 | 1268.1 | 206.049 | 2347.4 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 155°908 | $\frac{dt}{dp}$ (10 *mm*): | 0°5165 | ZMACZYNSKI (1930) |
| 156°1 | „ | 0°53 | LECAT (passim) |
| 156°15 | „ | 0°53 | TIMMERMANS (1912) and B.E. (1926) |
| 156°16 | „ | 0°49 | YOUNG (1902) |
| 156°2 | | | RICHARDS and BARRY (1915) |
| 156°3 | | | ROLLA (1909–10) |

The boiling point given by YOUNG: 156°0, was calculated by means of a formula which does not hold at this temperature. The observed boiling point was 156°16.

*Freezing point*

| | | | |
|---|---|---|---|
| −30°6 | B.E. (1926) and DEFFET (1940) | −30°67 | STULL (1937) |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| −30.6 | 1 | −18.0 | 693 | DEFFET (1940) |
| −23.2 | 416 | −13.0 | 914 | „ |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.52204 | B.E. (1926) | 0.1 | 1.5220 | MEYER and MYLIUS (1920) |
| 15 | 1.50170 | „ | 5.9 | 1.51410 | „ |
| 30 | 1.48150 | „ | 16.6 | 1.4998 | „ |
| 0 | 1.52182 | YOUNG (1910) | 18.2 | 1.4975 | „ |
| 10 | 1.50830 | „ | 21.9 | 1.4925 | „ |
| 20 | 1.4948 | „ | 28.3 | 1.4841 | „ |
| 30 | 1.4815 | „ | 33.1 | 1.4776 | „ |
| 0 | 1.52193 | TIMMERMANS (1912) | 43.6 | 1.4630 | „ |
| 20 | 1.49519 | ZMACZYNSKI (1930) | 49.5 | 1.4553 | „ |
| 20 | 1.4952 | DEZELIC (1937) | 61.4 | 1.4392 | „ |
| 25 | 1.48791 | BUGARSKI (1911) | 71.2 | 1.4257 | „ |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 1196 | B.E. (1926) | 15 | 36.93 | HENNAUT-ROLAND and |
| 30 | 985 | „ | 20 | 36.34 | „ LEE (1931) |
| 20 | 1124 | DEZELIC (1937) | 30 | 35.09 | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.55700 | 1.56252 | 1.57636 | 1.58837 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00048 | 49 | 50 | 52 | |
| 20 | — | 1.5602 | — | — | Fischer and Reichel (1943) |

**Heat constants**

*Specific heat:* Stull (1937)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −183.16 | 0.08360 | −103.16 | 0.1314 | L. −23.16 | 0.2229 |
| −173.16 | 0.08908 | − 93.16 | 0.1381 | −13.16 | 0.2289 |
| −163.16 | 0.09430 | − 83.16 | 0.1451 | − 3.16 | 0.2329 |
| −153.16 | 0.1000 | − 73.16 | 0.1519 | + 6.84 | 0.2350 |
| −143.16 | 0.1059 | − 63.16 | 0.1596 | +16.84 | 0.2359 |
| −133.16 | 0.1121 | − 53.16 | 0.1674 | +26.84 | 0.2368 |
| −123.16 | 0.1187 | − 43.16 | 0.1759 | +36.84 | 0.2384 |
| −113.16 | 0.1249 | − 33.16 | 0.1845 | +46.84 | 0.2420 |

| *Heat of melting* | 16.186 cal 15°/g | Stull (1937) |
|---|---|---|

## IODOBENZENE $C_6H_5I$

This compound is prepared by the action of nitric acid and iodine on benzene. Young's sample was not pure.

**Constants:** B.E. (1932). — **Polyphasic equilibria**

*Boiling point*

| | | | |
|---|---|---|---|
| 188°33 | Rolla (1909) | 188°45 | $\frac{dt}{dp}$ *(10 mm):* 0°56 Lecat (passim) |
| 188°36 | Holleman (1904) | 188°60 | Feitler (1889) |
| 188°45 | $\frac{dt}{dp}$ *(10 mm):* 0°57 B.E. (1932) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −31°27 | Stull (1937) | −31°35 | B.E. (1932) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.86102 | B.E. (1932) | 24.8 | 1.82363 | Patterson and Mac Donald (1908) |
| 15 | 1.83829 | „ | 31.25 | 1.8138 | „ |
| 30 | 1.81548 | „ | 25 | 1.8230 | Jaeger (1917) |
| 4 | 1.8551 | Perkin (1896) | 60 | 1.7699 | Perkin (1896) |
| 10 | 1.8458 | „ | 65 | 1.7622 | „ |
| 15 | 1.8384 | „ | 70 | 1.7544 | „ |
| 25 | 1.8230 | „ | 75 | 1.7468 | „ |
| 35 | 1.8077 | „ | 80 | 1.7391 | „ |
| 40 | 1.7996 | „ | 85 | 1.7319 | „ |
| 45 | 1.7928 | „ | 90 | 1.7238 | „ |
| 50 | 1.7854 | „ | 95 | 1.7165 | „ |
| 55 | 1.7777 | „ | 100 | 1.7092 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1740 | B.E. (1932) |
| 30 | 1417 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 14 | 41.21 | Sugden (1924) | 20 | 41.45 | Bodson (1937) |
| 50 | 36.93 | „ | 40 | 38.69 | „ |
| 98 | 31.62 | „ | 60 | 35.94 | „ |
| 124 | 28.80 | „ | 70 | 34.57 | „ |
| 146 | 26.27 | „ | 80 | 33.19 | „ |
| 169 | 23.91 | „ | | | |
| 180 | 22.64 | „ | | | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.61469 | 1.61559 | 1.62298 | 1.63735 | 1.64098 | 1.65221 |
| $\frac{dn}{dt}$ | 0.00054 | 53 | 55 | 58 | 58 | 58 |

*Specific magnetic rotatory power*

| t° | $\mu$ | | t° | $\mu$ | |
|---|---|---|---|---|---|
| 10.4 | 3.1176 | Perkin (1896) | 54.9 | 2.9910 | Perkin (1896) |
| 15.0 | 3.1024 | „ | 85.1 | 2.9368 | „ |

**Heat constants:** STULL (1937)

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −183.16 | 0.06330 | −103.16 | 0.1007 | L. −23.16 | 0.1815 |
| −173.16 | 0.06825 | − 93.16 | 0.1055 | −13.16 | 0.1830 |
| −163.16 | 0.07306 | − 83.16 | 0.1108 | − 3.16 | 0.1840 |
| −153.16 | 0.07776 | − 73.16 | 0.1160 | + 6.84 | 0.1846 |
| −143.16 | 0.08262 | − 63.16 | 0.1216 | +16.84 | 0.1854 |
| −133.16 | 0.08733 | − 53.16 | 0.1274 | +26.84 | 0.1861 |
| −123.16 | 0.09174 | − 43.16 | 0.1333 | +36.84 | 0.1863 |
| −113.16 | 0.09414 | − 33.16 | 0.1392 | +46.84 | 0.1884 |

| | |
|---|---|
| *Heat of melting* | 11.426 cal 15°/g |

## DIFLUOROBENZENES

| | *Meta* $m$-$C_6H_4F_2$ | | | *Para* $p$-$C_6H_4F_2$ | | |
|---|---|---|---|---|---|---|
| **Constants** | | | | | | |
| *Boiling point* | | — | | 88°82 | | SWARTS (1913–19) |
| *Melting point* | | — | | −23°7 | | „ |
| *Density:* | | — | | 18°5 | 1.1725 | SWARTS (1913–19) |
| | 16°2 | 1.16400 | SWARTS (1923) | 18°9 | 1.1722 | SWARTS (1923) |
| | 20° | 1.1571 | DESREUX (1935) | 20° | 1.17006 | DESREUX (1935) |
| *Viscosity:* $\eta \cdot 10^5$ | 20° | 574.3 | SWARTS (1931) | 20° | 639 | SWARTS (1931) |
| | 30° | 512.2 | „ | 30° | 568 | „ |
| | 40° | 461 | „ | 40° | 507.5 | „ |
| | 50° | 415.6 | „ | 50° | 456.5 | „ |
| | 60° | 378.6 | „ | 60° | 413.5 | „ |
| *Surface tension* | 20° | 25.93 | DESREUX (1935) | 20° | 27.05 | DESREUX (1935) |
| *Refractive index* | | | | | | |
| $H\alpha$ | 16° | 1.43509 | SWARTS (1923) | 18°9 | 1.43846 | SWARTS (1913) |
| D | | 1.43921 | „ | | 1.44219 | „ |
| $H\beta$ | | 1.44766 | „ | | 1.45157 | „ |
| $H\gamma$ | | 1.45556 | „ | | 1.45957 | „ |

## *Ortho*-DICHLOROBENZENE $o\text{-}C_6H_4Cl_2$

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 179°5 | Lecat (passim) | 180°35 | $\frac{dt}{dp}$ *(10 mm)*: 0°57 Carswell (1928) |

*Freezing point*

| | | | |
|---|---|---|---|
| −16°7 | Carswell (1928) | −17°2 | Kalff (1924) |

*Density*

| t° | d | |
|---|---|---|
| 15 | 1.3100 | Carswell (1928) |
| 20 | 1.3064 | „ |

*Refractive index*

| t° | He r. | D | He y. | He g. | He v. | |
|---|---|---|---|---|---|---|
| 12.8 | 1.54936 | — | 1.55526 | 1.56560 | 1.57614 | Kalff (1924) |
| 32.8 | 1.53962 | — | 1.54544 | 1.55553 | 1.56590 | „ |
| $\frac{dn}{dt}$ | 0.00048 | — | 49 | 50 | 51 | „ |
| 22 | — | 1.5518 | — | — | — | Carswell (1928) |

*Dielectric constant*: 25°: 6.8281 Le Fevre and Le Fevre (1936)

## *Para*-DICHLOROBENZENE $p\text{-}C_6H_4Cl_2$

### Constants

*Saturated vapour pressure*

| t° | p mm | |
|---|---|---|
| 10 | 0.232 | Darkis, Vermillon and Gross (1940) |
| 30 | 1.63 | „ |
| 50 | 8.435 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 173°7 | Perkin (1896) | 174°4 | Lecat (passim) |
| 173°8 | Kruyt (1912) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| 53°2 | Hrynakowski and Szmyt (1938) | 53°13 | Cooper (1926–'27) |
| 53°2 | Morris and Cook (1935) | 53°08 | Campbell and Prodan (1948) |
| 53°2 | Martin and Georges (1933) | 53°0 | Beck and Ebbinghaus (1906) |
| 53°2 | Kalff (1924) | 53°0 | Hrynakowski and Smoczkiewiczowa (1937) |
| 53°2 | Perkin (1896) | | |
| 53°15 | Deffet (1938) | 53°0 | Kruyt (1912) |

*Melting curve:* Deffet (1938–1940)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 53.15 | 1 | 70.00 | 510 |
| 55.00 | 45 | 75.00 | 660 |
| 60.00 | 196 | 80.00 | 812 |
| 65.00 | 353 | 85.00 | 956 |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 55 | 1.2495 | Perkin (1896) | 75 | 1.2264 | Perkin (1896) |
| 60 | 1.2437 | „ | 80 | 1.2207 | „ |
| 65 | 1.2378 | „ | 90 | 1.2112 | „ |
| 70 | 1.2321 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 68 | 30.69 | Sugden (1924) | 150 | 22.05 | Sugden (1924) |
| 96 | 27.58 | „ | 166 | 20.44 | „ |
| 117 | 25.44 | „ | 170 | 19.82 | „ |
| 139 | 22.92 | „ | | | |

*Refractive index*

| t° | He r. | He y. | He g. | He v. | |
|---|---|---|---|---|---|
| 55.2 | 1.52397 | 1.52988 | 1.53991 | 1.55017 | Kalff (1924) |
| 77.2 | 1.51307 | 1.51877 | 1.52859 | 1.53865 | „ |

Melting point, density and refractive index of *meta*-dichloro, 1,2,3-, 1,2,4-, 1,3,5-trichloro-, *ortho*-, *meta*- and *para*-tetrachloro- and pentachloro-benzene are given by Kalff (1924). The melting points and the refractive indexes seem good; the densities are affected by a systematic error.

## *Para*-DIBROMOBENZENE $p\text{-}C_6H_4Br_2$

### Constants

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 220°25 | LECAT (passim) | 87·30 | CAMPBELL and PRODAN (1948) |
| | | 87°3 | DEFFET (1938) |
| | | 87°2 | KRUYT (1912) |

*Melting curve:* DEFFET (1938–1940)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 87.3 | 1 | 110.0 | 640 |
| 95.0 | 213 | 115.0 | 790 |
| 100.0 | 348 | 120.0 | 931 |

*Viscosity:* from 94°8 to 193°2 GOLIK and RAVIKOVITCH (1949)

1,2,3; 1,2,4 and 1,3,5-TRICHLOROBENZENES and HEXACHLOROBENZENE

*Saturated vapour pressure* and *melting point:* SEARS and HOPKE (1949)

## Derivatives of Toluene

## FLUOROTOLUENES $C_6H_4F—CH_3$

### Constants

| | | *Ortho* | *Meta* | *Para* | |
|---|---|---|---|---|---|
| *Density* | $d_4^t$ | 17°3 1.00142<br>SWARTS (1923) | 20° 0.9974<br>DESREUX (1935) | — | |
| *Viscosity:* $\eta \cdot 10^5$ | 20° | 679.5 | 608 | 621.5 | SWARTS (1931) |
| | 30° | 600.5 | 534 | 552.5 | „ |
| | 40° | 537.5 | 481 | 495 | „ |
| | 50° | 481 | 453.7 | — | „ |
| | 60° | 434 | 395.5 | 405 | „ |
| *Surface tenstion* | | — | 20° 27.97 | — | DESREUX (1935) |
| *Refractive index* | | 17°3 | | | |
| | Hα | 1.46705 | — | — | SWARTS (1923) |
| | D | 1.47161 | | | |
| | Hβ | 1.48235 | | | |
| | Hγ | 1.49690 | | | |

## PHENYLFLUOROFORM or BENZOTRIFLUORIDE $C_6H_5—CF_3$

Prepared by SWARTS by the action of $SbF_3$ on $C_6H_5CCl_3$ and purified by fractional distillation.

**Constants**

*Boiling point:* 103°46 SWARTS (1919)

*Density*

| t° | d | |
|---|---|---|
| 13.3 | 1.19040 | SWARTS (1923) |
| 19.2 | 1.18857 | „ (1919) |
| 20 | 1.1886 | DESREUX (1935) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 19.8 | 574.0 | SWARTS (1931) | 50 | 420.4 | SWARTS (1931) |
| 30 | 512.0 | „ | 60 | 387.3 | „ |
| 40 | 462.4 | „ | | | |

*Surface tension:* 20°: 23.39 DESREUX (1935)

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 13.3 | 1.41180 | 1.41486 | 1.42287 | 1.42918 | SWARTS (1923) |

## BENZYL CHLORIDE $C_6H_5—CH_2Cl$

This substance is very unstable when hot and is oxidized by air with the loss of HCl.

**Constants:** B.E. (1935)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 48.3 | 0 | KAHLBAUM (1884) | 76.1 | 20 | KAHLBAUM (1884) |
| 58.7 | 5 | „ | 80.5 | 25 | „ |
| 66.1 | 10 | „ | 94.2 | 50 | „ |
| 71.3 | 15 | „ | 102.8 | 75 | „ |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 179°0 | KAHLBAUM (1884) | −39°2 | B.E. (1935) |
| 179°3 | LECAT (passim) | | |
| 179°35 | TIMMERMANS (1913) | | |

| *Density* | | *Viscosity* | | *Surface tension* | | |
|---|---|---|---|---|---|---|
| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ | |
| 0 | 1.11875 | 15 | 1501 | 15 | 38.43 | B.E. (1935) |
| 15 | 1.10426 | 30 | 1175 | 20 | 37.80 | „ |
| 30 | 1.08977 | | | 30 | 36.63 | „ |
| — | — | 25 | 1280 | — | — | DUNSTAN, HILDITCH and THOLE (1913) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.53570 | 1.53638 | (1.54124) | 1.54150 | 1.55190 | 1.55407 | 1.56190 |
| $\frac{dn}{dt}$ | 0.00048 | 48 | — | 49 | 49 | 49 | 50 |

## PHENYLCHLOROFORM or BENZOTRICHLORIDE $C_6H_5—CCl_3$

Prepared by chlorination of toluene in the presence of 2 % of phosphorus trichloride, and purified by fractional distillation. Phenylchloroform is very unstable.

**Constants**

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 220°64 | SWARTS (1923) | −4°75 | SWARTS (1923) |
| 220°8 | LECAT (passim) | −5°0 | HOLLEMAN (1914) |

| *Density* | | | *Surface tension* | | |
|---|---|---|---|---|---|
| t° | d | | | | |
| 15 | 1.3775 | SWARTS (1923) | 20° | 38.03 | DESREUX (1935) |
| 20 | 1.3723 | DESREUX (1935) | | | |

## *Ortho*-CHLOROTOLUENE $o\text{-}C_6H_4Cl—CH_3$

**Constants:** B.E. (1930)

*Boiling point* / *Freezing point*

| | | | |
|---|---|---|---|
| 159°15 | $\frac{dt}{dp}$ *(10 mm)*: 0°52 | −36°5 | |
| 159°2 | Lecat (passim) | | |

*Density* / *Viscosity* / *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ |
|---|---|---|---|---|---|
| 0 | 1.10180 | 15 | 1037 | 15 | 33.99 |
| 15 | 1.08729 | 30 | 887 | 20 | 33.44 |
| 30 | 3.07279 | | | 30 | 32.33 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.52254 | 1.52322 | 1.52827 | 1.53770 | 1.53997 | 1.54747 | 1.55051 |
| $\frac{dn}{dt}$ | 0.00045 | 46 | 48 | 48 | 48 | 48 | 47 |

Bingham and Geddes (1934) measured the densities and viscosities of the three chloro- and bromo-toluenes at various temperatures. For *ortho*-chlorotoluene, these densities and those of B.E. do not agree; for *para*-bromotoluene, the densities are 6/10,000 lower than those of Perkin. We are not aware of any other comparison data.

## *Para*-CHLOROTOLUENE $p\text{-}C_6H_4Cl—CH_3$

**Constants**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 40.3 | 5 | 59.6 | 20 | 77.7 | 50 | Kahlbaum (1884) |
| 48.9 | 10 | 63.7 | 25 | 84.9 | 75 | ,, |
| 54.2 | 15 | | | | | ,, |

*Boiling point:* 162°4 Lecat (passim)
162°50 Feitler (1889)

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 10 | 103 | Bingham and Geddes | 60 | 56 | Bingham and Geddes |
| 20 | 89 | „ (1934) | 80 | 47 | „ (1934) |
| 30 | 78 | „ | 100 | 40 | „ |
| 40 | 70 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 25 | 32.24 | Sugden (1924) | 108 | 23.32 | Sugden (1924) |
| 30 | 29.22 | „ | 120 | 22.11 | „ |
| 64 | 27.96 | „ | 151 | 19.11 | „ |
| 79 | 26.17 | „ | | | |

## *Ortho*-BROMOTOLUENE $o\text{-}C_6H_4Br—CH_3$

### Constants

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 44.4 | 0 | Kahlbaum (1884) | 75.2 | 20 | Kahlbaum (1884) |
| 55.4 | 5 | „ | 79.6 | 25 | „ |
| 63.4 | 10 | „ | 95.7 | 50 | „ |
| 69.8 | 15 | „ | 104.4 | 75 | „ |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 181 | Perkin (1896) | −28°1 | Timmermans (passim) |
| 181°5 | Lecat (passim) | | |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 0 | 221 | Bingham and Geddes | 40 | 112 | Bingham and Geddes |
| 10 | 181 | „ (1934) | 60 | 87 | „ (1934) |
| 20 | 151 | „ | 80 | 71 | „ |
| 30 | 129 | „ | 100 | 59 | „ |

*Specific magnetic rotatory power:* 16°7 2.3556 Perkin (1896)

## *Para*-BROMOTOLUENE $p$-$C_6H_4Br—CH_3$

**Constants**

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 185°0 | Lecat (passim) | 26°7 | Van der Laan (1907) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 35 | 1.3877 | Perkin (1896) | 70 | 1.3441 | Perkin (1896) |
| 40 | 1.3813 | „ | 75 | 1.3338 | „ |
| 45 | 1.3752 | „ | 80 | 1.3316 | „ |
| 50 | 1.3691 | „ | 85 | 1.3241 | „ |
| 55 | 1.3630 | „ | 90 | 1.3190 | „ |
| 60 | 1.3569 | „ | 95 | 1.3128 | „ |
| 65 | 1.3505 | „ | 100 | 1.3076 | „ |
| 30 | 1.3937 | Bingham and Geddes | 80 | 1.3319 | Bingham and Geddes |
| 40 | 1.3816 | „ (1934) | 100 | 1.3074 | „ (1934) |
| 60 | 1.3563 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 30 | 109.5 | Bingham and Geddes | 60 | 76.8 | Bingham and Geddes |
| 40 | 94.4 | „ (1934) | 100 | 53.1 | „ (1934) |

*Dielectric constant:* 28° 5.07 Cauwood and Turner (1915)

*Specific magnetic rotatory power:* 39° 2.2084; 89° 2.1351 Perkin (1896)

## 1,1-DI-*p*-CHLOROPHENYL-2,2,2-TRICHLOROETHANE $(C_6H_4Cl)_2CH—CCl_3$

*Saturated vapour pressure* Kuhn and Massini (1949)

## Derivatives of Naphthalene

### α-BROMONAPHTHALENE $\alpha\text{-}C_{10}H_7Br$

**Constants:** B.E. (1937)

*Boiling point*

| | |
|---|---|
| 281·2 | LECAT (passim) |

*Melting point*

| | |
|---|---|
| 6°10 | B.E. (1937) and DEFFET (1940) |
| 6°20 | JONES and LAPWORTH (1914) |

*Melting curve*

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 6.10 | 1 | DEFFET (1940) | 25.00 | 703 | DEFFET (1940) |
| 16.00 | 370 | „ | 30.00 | 885 | „ |
| 20.00 | 518 | „ | | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.50343 | B.E. (1937) | 20 | 1.4834 | JONES and LAPWORTH |
| 15 | 1.48834 | „ | 25 | 1.4785 | „ (1914) |
| 30 | 1.47317 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 5993 | B.E. (1937) |
| 30 | 4031 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 45.16 | B.E. (1937) |
| 20 | 44.59 | „ |
| 30 | 43.36 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.64993 | (1.65120) | (1.66069) | 1.66033 | 1.67893 | (1.68385) | 1.69926 | — | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00043 | — | — | 0.00044 | 0.00044 | — | 0.00044 | — | „ |
| (Hα, D, Hβ, are interpolated values) | | | | | | | | | |
| 20 | — | 1.6494 | 1.6582 | — | — | 1.6819 | — | 1.7037 | JONES and LAPWORTH (1914) |

# H. HALOGENATED DERIVATIVES OF THE CYCLOPARAFFINS

## *Cyclo*PENTYL CHLORIDE $C_5H_9Cl$

**Constants**: La Bruyere (unp.)

*Freezing point:* −94°3

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ |
|---|---|---|---|---|---|
| 0 | 1.02965 | 15 | 1070 | 15 | 31.27 |
| 15 | 1.01398 | 30 | 867 | 20 | 30.64 |
| 30 | 0.99825 | | | 30 | 29.39 |

*Refractive index*

| t° | He r. | He y. | He g. | He v. |
|---|---|---|---|---|
| 15 | 1.45108 | 1.45394 | 1.45872 | 1.46348 |
| $\frac{dn}{dt}$ | 0.00042 | 43 | 45 | 45 |

*Cyclo*pentylfluoride, bromide, iodide and *cyclo*pentylidene chloride: Rogers and Roberts (1946). Perfluorodimethyl*cyclo*pentane and perfluorethyl*cyclo*pentane: Fowler, Hamilton Jr., Kasper, Weber, Burford III and Anderson (1947).

Nona- and Perfluoro-*cyclo*-pentane: Rohrback and Cady (1949).

## TRIFLUOROMETHYL-*cyclo*-HEXANE or *Cyclo*-HEXYLFLUOROFORM $C_6H_{11}—CF_3$

Prepared by catalytic hydrogenation of phenylfluoroform.

**Constants**: Swarts (1923—31)

*Boiling point:* 107°20 *Melting point:* −103°4 *Density:* 11°5 1.0908

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 20 | 951 | Swarts (1931) | 50 | 648.5 | Swarts (1931) |
| 30 | 829 | " | 60 | 575 | " |
| 40 | 733.5 | " | | | |

Perfluoromethyl*cyclo*hexane, perfluoro-*o*-dimethyl*cyclo*hexane, perfluoro-*m*-dimethyl*cyclo*hexane, perfluoro-*p*-dimethyl*cyclo*hexane, perfluoro-1,3,5-trimethyl*cyclo*hexane and perfluorohexahydroindane: Fowler, Hamilton, Kasper, Weber, Burford III and Anderson (1947).

Hexachloro-*cyclo*-hexanes $\alpha$, $\beta$, $\gamma$, $\delta$: *Saturated vapour pressure:* Balson (1947).

# 3. OXYGENATED DERIVATIVES OF THE ALIPHATIC SERIES

## A. ALCOHOLS

### METHYL ALCOHOL $CH_3OH$

Methyl alcohol is purified by transformation into a solid ester, either the oxalate according to RAMSAY and YOUNG (1887) or the potassium methyl sulphate according to KLASON and NORLIN (1906).

For the determination of impurities (acetone, formaldehyde, etc.) see BATES, MULLALY and HARTLEY (1923), HARTLEY and RAIKES (1925) and GILLO (1938).

According to GILLO (1938) formaldehyde is determined by SCHIFF's reagent (decolorised fuchsin) down to $10^{-4}$ %; acetone is determined by the iodoform reaction, by vanillin, by NESSLER's reagent or by ebulliometry and may be detected down to $10^{-3}$ or $10^{-4}$ %.

Complete dehydration is obtained by fractional distillation (YOUNG and FORTEY (1902) or by distillation over metallic sodium (CRISMER, 1904; B.E., 1930; GILLO, 1938 [the fifth degree of purity can easily be attained]); distillation over calcium (KLASON and NORLIN, 1906) or magnesium (BJERRUM and ZEICHMEISTER, 1923) is less satisfactory; neither do lime or baryte lead to complete dehydration. Traces of water can be estimated by a determination of the density to the fifth figure; also by measuring of the t°cr.s. in petroleum (CRISMER); T.C.S. in cyclohexane (B.E.); by determining the speed of esterification of methyl oxalate; or by measuring the electrical conductivity of a $10^{-3}$ N solution of hydrochloric acid (GOLDSCHMIDT, 1924). By measuring crystallization velocities (MICHEL; 1938), it is possible to demonstrate the presence of 0.005 % water. Owing to its hygroscopicity, this substance must be kept in sealed tubes.

**Constants** B.E. (1930). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 240 | 29660 | — | YOUNG (1910) |
| 240.2 | — | 0.275 | CENTNERSZWER (1904) |

*Densities of the liquid and the saturated vapour:* YOUNG (1900–1910)

| t° | L. | V. | t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.8100 | 0.0000562 | 100 | 0.7140 | 0.003984 | 200 | 0.5530 | 0.05075 |
| 10 | 0.8008 | 0.0000996 | 110 | 0.7020 | 0.005376 | 210 | 0.5255 | 0.06521 |
| 20 | 0.7915 | 0.0001695 | 120 | 0.6900 | 0.007142 | 220 | 0.4900 | 0.08635 |
| 30 | 0.7825 | 0.0002772 | 130 | 0.6770 | 0.009379 | 225 | 0.4675 | 0.1003 |
| 40 | 0.7740 | 0.0004394 | 140 | 0.6640 | 0.01216 | 230 | 0.4410 | 0.1187 |
| 50 | 0.7650 | 0.0006739 | 150 | 0.6495 | 0.01562 | 232 | 0.4295 | 0.1277 |
| 60 | 0.7555 | 0.001006 | 160 | 0.6340 | 0.01994 | 234 | 0.4145 | 0.1381 |
| 70 | 0.7460 | 0.001465 | 170 | 0.6160 | 0.02526 | 236 | 0.3955 | 0.1505 |
| 80 | 0.7355 | 0.002084 | 180 | 0.5980 | 0.03186 | 238 | 0.3705 | 0.1681 |
| 90 | 0.7250 | 0.002907 | 190 | 0.5770 | 0.04010 | 238.5 | 0.3635 | 0.1789 |

*Rectilinear diameter:* $0.4050 - 4479 \cdot 10^{-7} t° + 1330 \cdot 10^{-10} t°^2 - 23760 \cdot 10^{-13} t°^3$

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −44.4 | 0.986 | −54.5 | 0.379 | −66.3 | 0.110 | MÜNDEL (1913) |
| −46.5 | 0.820 | −57.0 | 0.295 | −67.4 | 0.102 | „ |
| −48.1 | 0.702 | −60.4 | 0.212 | | | „ |
| −51.9 | 0.491 | −62.5 | 0.166 | | | „ |
| −10 | 15.5 | 120 | 4751 | 230 | 50414 | YOUNG (1910) |
| 0 | 29.6 | 130 | 6242 | 232 | 52202 | „ |
| 10 | 54.7 | 140 | 8071 | 234 | 53939 | „ |
| 20 | 96.0 | 150 | 10336 | 236 | 55624 | „ |
| 30 | 160.0 | 160 | 13027 | 237 | 56995 | „ |
| 40 | 260.5 | 170 | 16292 | 238 | 57576 | „ |
| 50 | 406.0 | 180 | 20089 | 238.5 | 58329 | „ |
| 60 | 625.0 | 190 | 24615 | 239 | 58741 | „ |
| 80 | 1341.0 | 200 | 29787 | 239.5 | 59145 | „ |
| 90 | 1897 | 210 | 35770 | 240 | 59660 | „ |
| 100 | 2621 | 220 | 42573 | | | „ |
| 110 | 3561 | 225 | 46297 | | | „ |
| 15.0 | 72.4 | 43.0 | 292.4 | 53.9 | 470.3 | KONOVALOW (1881) |
| 29.3 | 153.4 | 43.15 | 295.0 | 65.4 | 756.6 | „ |

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 18.5 | 89.1 | JOUKOVSKY (1934) | 62.53 | 700 | DOROCHEVSKY and POLIANSKY (1910) |
| 20.0 | 96.3 | „ | 64.57 | 760 | „ |
| 20.5 | 99.0 | „ | 65.92 | 800 | „ |
| 30.0 | 160.2 | „ | | | |
| 49.76 | 404.6 | BREDIG and BAYER (1927) | 15 | 73.61 | TOWER and GERMANN (1914) |
| 39.76 | 259.8 | „ | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 64°501 | Wojciechowsky (1936) | 64·63 | De Brouckere and Gillet (1935) |
| 64°509 | Stull (1937) | 64·65 | Atkins and Wallace (1913) |
| 64°51 | Maryott (1941) | 64·65 | B.E. (1930) and Lecat (passim) |
| 64°53 | Dorochewsky (1909) | 64°7 | Young and Fortey (1902) |
| 64·57 | Dorochewsky and Poliansky (1910) | 64·75 | Briscoe and Rinchart (1942) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°33 | Ramsay and Young (1887) | 0·34 | Dorochewsky and Poliansky (1910) |
| 0°34 | Dittmar and Fawsitt (1886–87) | 0°35 | B.E. (1930) and Lecat (passim) |

*Freezing point*

| | | | |
|---|---|---|---|
| −97°0 | B.E. (1930) | −97°68 | Roper (1938) |
| −97°43 | Stull (1937) | −97°88 | Kelley (1929) |

*Critical solution point:*

in $CS_2$: 34°9 Roland (1927)
„ 35°2 Maryott ((1941)
in $C_6H_{14}$: 34°50 Roland (1927)
in $C_6H_{12}$: 46°05 „

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.8100 | Young (1910) | 0 | 0.81005 | B.E. (1930) |
| 10 | 0.8008 | „ | 15 | 0.79609 | „ |
| 20 | 0.7915 | „ | 30 | 0.78208 | „ |
| 0 | 0.81009 | Pesce (1940) | 25 | 0.7866 | Briscoe and Rinchart (1942) |
| 25 | 0.78662 | „ | 30 | 0.7819 | „ |
| 45 | 0.76761 | „ | 40 | 0.7725 | „ |
| | | | 50 | 0.7628 | „ |
| 0 | 0.809985 | Rakowski and Frost (1930) | 15 | 0.7960 | Mueller and Abegg (1906–1907) |
| 5 | 0.80535 | „ | | | |
| 25 | 0.78654 | „ | 15 | 0.79602 | Klason and Norlin (1906) |
| 30 | 0.78181 | „ | 15 | 0.79602 | Dorochewsky (1911) |

*Density* (continued)

| | | | | | |
|---|---|---|---|---|---|
| 20 | 0.79130 | Zepalova-Mikhaïlova (1939) | 25 | 0.78657 | Gibson and Kincaid (1937) |
| 20 | 0.79140 | Crismer (1904) | 25 | 0.78658 | Barr and Bircumshaw (1921) |
| 20 | 0.7915 | Lowry (1914) | 25 | 0.7866 | Larson and Herschel Hunt (1939) |
| 25 | 0.786525 | Jones and Fornwalt (1938) | | | |
| 25 | 0.78654 | Eckfeldt and Lucasse (1943) | 25 | 0.786644 | Stark and Gilbert (1937) |
| 25 | 0.78655 | Gibson (1935) | 25 | 0.78668 | Betts and Hammett (1937) |
| 25 | 0.78655 | Munn, Anderson and Morris (1942) | 25 | 0.7867 | Herz and Schuftan (1922) |
| | | | 25 | 0.78675 | Kelley (1929) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 623 | B.E. (1930) |
| 30 | 510 | „ |
| 25 | 544 | Jones and Fornwalt (1938) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 22.99 | B.E. (1930) |
| 20 | 22.55 | „ |
| 30 | 21.69 | „ |
| 22 | 22.47 | Kosakewitsch (1928) |
| 25 | 22.18 | Larson and Herschel Hunt (1939) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.32860 | 1.32897 | — | 1.33066 | 1.33372 | 1.33446 | 1.33682 | 1.33752 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00039 | 0.00040 | — | 39 | 39 | 40 | 41 | 39 | „ |
| 15 | — | — | 1.33057 | — | — | — | — | — | Dorochewsky (1911 |
| 16 | — | — | — | 1.33023 | — | — | — | — | Joukovsky (1934) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|
| L. 3.20 | 0.5714 | 23.46 | 0.6081 | Bose (1906) and Bose and Müller (1907) |
| 3.64 | 0.5727 | 39.93 | 0.6112 | „ |
| 4.05 | 0.5742 | 40.52 | 0.6115 | „ |
| 23.39 | 0.6050 | 41.51 | 0.6120 | „ |

*Specific heat* (continued)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −254.36 | 0.03462 | −199.21 | 0.2620 | L. −88.06 | 0.5204 | Kelley (1929) |
| −251.61 | 0.04720 | −195.55 | 0.2727 | −76.39 | 0.5239 | ,, |
| −248.73 | 0.06156 | −191.68 | 0.2810 | −51.47 | 0.5332 | ,, |
| −245.91 | 0.07155 | −187.64 | 0.2902 | −37.32 | 0.5435 | ,, |
| −242.44 | 0.08832 | −183.87 | 0.3026 | −16.82 | 0.5526 | ,, |
| −238.83 | 0.10730 | −179.98 | 0.3103 | − 6.15 | 0.5660 | ,, |
| −235.52 | 0.1237 | −175.94 | 0.3194 | + 0.42 | 0.5713 | ,, |
| −232.29 | 0.1382 | −162.02 | 0.3506 | 4.65 | 0.5763 | ,, |
| −229.23 | 0.1511 | −158.34 | 0.3584 | 12.09 | 0.5838 | ,, |
| −225.09 | 0.1687 | −155.19 | 0.3634 | 19.85 | 0.5966 | ,, |
| −217.13 | 0.2006 | −147.79 | 0.3802 | | | ,, |
| −213.63 | 0.2137 | −139.45 | 0.3946 | | | ,, |
| −209.87 | 0.2264 | −125.30 | 0.4049 | | | ,, |
| −203.21 | 0.2498 | | | | | ,, |

*Heat of vaporisation* cal 15°/g.

| | | | | |
|---|---|---|---|---|
| 50° | 0.2699 | 90° | 0.2498 | Fioch, Ginnings and Holton (1931) |
| 64°7 | 0.2631 | 110° | 0.2371 | ,, |
| 20° | 0.287 | | | Bartoszewiczowna (1931) |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 5419.9 cal 15°/g | Rossini (1932) |

## ETHYL ALCOHOL $C_2H_5OH$

Osborne, Kelvy and Bearce (1913) have published a very complete monograph concerning the purification and the properties of anhydrous alcohol; this work gives the complete literature until 1913. Previously the most important papers were those of Mendelejeff (1869–1887); Young (1902); Crismer (1904). Among the more recent works concerning anhydrous alcohol, those of Merriman (1913), Brunel, Crenshaw and Tobin (1921) and Brunel (1923) are noteworthy.

Cox has published (1919) a paper on the influence of ether upon the density of absolute alcohol.

Determination of impurities: Gillo (1938): acetaldehyde is determined by means of Schiff's reaction down to $10^{-4}$%; methylethylcetone to $10^{-3}$% by Nessler's reagent, iodoform, vanillin or ebulliometry; furfurol to $10^{-4}$% by means of the aniline-acetic acid reagent.

Because of the existence of the binary constant-boiling mixture with water

(4.4 %), the boiling point of which is only 0°1 lower than that of anhydrous alcohol, absolute alcohol cannot be obtained merely by distillation.

Complete dehydration can be obtained by boiling over lime (this treatment produces traces of aldehyde); also by distillation with a third component such as benzene which yields a ternary constant-boiling mixture with alcohol and water (YOUNG). The course of dehydration can be followed to completeness by determination of the density to the fifth figure or by measuring the speed of saponification of an ester (KAILAN, 1911) or by measuring the t°cr.s. in petroleum (CRISMER).

GILLO uses $CS_2$ as a third component and thus obtains, without difficulty, the fifth degree of purity by ebulliometry. This substance must be kept in sealed tubes.

**Constants. — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 243.1 | 47850 | 0.2755 | YOUNG (1910) |

*Densities of the liquid and the saturated vapour:* YOUNG (1910)

| t° | L. | V. | t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.80625 | 0.000033 | 100 | 0.7157 | 0.00351 | 190 | 0.5782 | 0.0397 |
| 10 | 0.7979 | 0.000062 | 110 | 0.7057 | 0.00486 | 200 | 0.5568 | 0.0508 |
| 20 | 0.7894 | 0.000111 | 120 | 0.6925 | 0.00658 | 210 | 0.5291 | 0.0655 |
| 30 | 0.7810 | 0.000191 | 130 | 0.6789 | 0.00877 | 220 | 0.4958 | 0.0854 |
| 40 | 0.7722 | 0.000315 | 140 | 0.6631 | 0.01152 | 230 | 0.4550 | 0.1135 |
| 50 | 0.7633 | 0.000506 | 150 | 0.6489 | 0.01488 | 240 | 0.3825 | 0.1715 |
| 60 | 0.7541 | 0.000790 | 160 | 0.6329 | 0.01916 | 241 | 0.3705 | 0.1835 |
| 70 | 0.7436 | 0.00119 | 170 | 0.6165 | 0.02446 | 242 | 0.3546 | 0.1990 |
| 80 | 0.7348 | 0.00174 | 180 | 0.5984 | 0.03115 | 242.5 | 0.3419 | 0.2164 |
| 90 | 0.7251 | 0.00250 | | | | | | |

*Rectilinear diameter:* $0.4028 - 3827 \cdot 10^{-7}\, t° - 5940 \cdot 10^{-10}\, t°^2 + 651 \cdot 10^{-13}\, t°^3$ YOUNG (1900-10)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −99.3 | $1.26 \cdot 10^{-3}$ | −81.5 | $5.96 \cdot 10^{-3}$ | −41.0 | $296 \cdot 10^{-3}$ | DRUCKER, JIMENO and KANGRO (1915) |
| −95.7 | 1.74 „ | −70.9 | 17.4 „ | −39.3 | 388 „ | |
| −91.8 | 2.39 „ | −61.2 | 44.0 „ | | | „ |
| −84.7 | 4.38 „ | −52.6 | 102.9 „ | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −2.05 | 10.1 | 11.05 | 25.0 | 29.20 | 75.0 | 74.37 | 649.7 | Merriman (1913) |
| −0.20 | 11.8 | 11.98 | 26.6 | 30.04 | 78.8 | 76.24 | 700.7 | „ |
| +0.53 | 12.5 | 12.30 | 27.3 | 34.18 | 98.8 | 77.98 | 750.2 | „ |
| 0.87 | 12.8 | 12.93 | 28.4 | 39.71 | 132.7 | 78.62 | 768.5 | „ |
| 1.39 | 13.3 | 13.68 | 29.7 | 42.23 | 150.8 | 79.60 | 800.1 | „ |
| 2.15 | 13.9 | 14.01 | 30.5 | 47.70 | 198.1 | 82.63 | 899.7 | „ |
| 2.90 | 15.0 | 14.34 | 30.8 | 49.68 | 218.1 | 85.39 | 999.6 | „ |
| 3.99 | 15.9 | 14.35 | 31.1 | 52.26 | 247.0 | 86.01 | 1021.8 | „ |
| 4.94 | 16.8 | 16.10 | 34.5 | 56.46 | 300.3 | 87.97 | 1099.9 | „ |
| 5.34 | 17.3 | 17.50 | 37.6 | 59.66 | 347.8 | 90.30 | 1199.6 | „ |
| 6.25 | 18.4 | 20.00 | 43.6 | 62.89 | 400.5 | 92.55 | 1301.0 | „ |
| 7.11 | 19.4 | 20.30 | 44.6 | 65.55 | 448.8 | 94.62 | 1401.7 | „ |
| 8.11 | 20.8 | 22.08 | 49.5 | 68.00 | 498.7 | 96.56 | 1501.1 | „ |
| 8.74 | 21.7 | 24.39 | 57.2 | 70.30 | 549.7 | 98.39 | 1599.9 | „ |
| 9.07 | 22.3 | 28.53 | 72.5 | 72.30 | 597.1 | 99.76 | 1679.0 | „ |
| 9.60 | 23.0 | | | | | | | |
| 0 | 12.24 | 130 | 4320 | 190 | 18178 | 241 | 46210 | Young (1910) |
| 10 | 23.77 | 140 | 5666 | 200 | 22164 | 242 | 46917 | „ |
| 20 | 44.00 | 150 | 7326 | 210 | 26821 | 242.5 | 47206 | „ |
| 30 | 78.06 | 160 | 9366 | 220 | 32097 | 243.1 | 47850 | „ |
| 90 | 1194 | 170 | 11856 | 230 | 38176 | | | „ |
| 110 | 2356 | 180 | 14763 | 240 | 45504 | | | „ |
| 0 | 11.95 | 34.988 | 103.03 | 50.000 | 220.94 | 65.000 | 438.04 | Kretschmer and |
| 25.000 | 59.02 | 44.994 | 172.95 | 54.988 | 279.79 | 78.553 | 766.71 | Wiebe (1949) |
| 7.9 | 20 | 14.5 | 31 | 29.6 | 75 | 65.5 | 450 | Kahlbaum and |
| 8.5 | 21 | 15.0 | 32 | 34.4 | 100 | 68.0 | 500 | Wirkner (1898– |
| 9.2 | 22 | 15.5 | 33 | 42.1 | 150 | 70.2 | 550 | „ 1897) |
| 9.8 | 23 | 16.0 | 34 | 47.8 | 200 | 72.4 | 600 | „ |
| 10.5 | 24 | 16.5 | 35 | 52.4 | 250 | 74.4 | 650 | „ |
| 11.1 | 25 | 16.9 | 36 | 56.4 | 300 | 76.1 | 700 | „ |
| 11.7 | 26 | 17.4 | 37 | 59.9 | 350 | 77.6 | 750 | „ |
| 12.3 | 27 | 18.9 | 41.3 | 62.8 | 400 | 78.0 | 760 | „ |
| 12.9 | 28 | 35.5 | 106.3 | | | | | „ |
| 13.4 | 29 | 49.3 | 215.3 | | | | | „ |
| 14.0 | 30 | 65.2 | 443.8 | | | | | „ |
| 14.0 | 30.6 | 27.4 | 67.4 | 39.8 | 133.4 | 58.0 | 321.6 | Schmidt (1891) |
| 16.4 | 35.4 | 28.2 | 70.4 | 44.4 | 168.0 | 59.8 | 349.7 | „ |
| 18.4 | 39.7 | 29.0 | 73.8 | 46.3 | 184.3 | 62.6 | 396.0 | „ |
| 20.0 | 43.6 | 30.4 | 80.4 | 49.2 | 212.5 | 64.4 | 429.7 | „ |
| 22.5 | 50.8 | 31.4 | 84.8 | 49.8 | 218.4 | 66.7 | 474.2 | „ |
| 23.9 | 55.0 | 32.4 | 89.4 | 51.8 | 241.7 | 70.1 | 545.3 | „ |
| 25.6 | 60.6 | 35.0 | 103.3 | 53.8 | 266.0 | 72.1 | 594.6 | „ |
| 26.5 | 64.2 | 37.4 | 116.4 | 56.2 | 297.2 | 78.3 | 761.3 | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 18.03 | 39.11 | 43.06 | 155.80 | 100.27 | 1741.5 | Crafts (1913) |
| 30.74 | 81.15 | 89.66 | 1172.7 | | | ,, |
| 18.7 | 41.3 | 49.5 | 215.3 | 78.55 | 766.5 | Konovalow (1881) |
| 35.5 | 106.3 | 65.4 | 443.8 | | | ,, |
| 21.81 | 47.6 | 59.92 | 351.0 | 75.36 | 676.8 | Schouteden and Deveux (1936) |
| 30.41 | 82.2 | 65.50 | 448.9 | 80.65 | 840.3 | ,, |
| 50.44 | 224.4 | 70.33 | 549.3 | 85.97 | 979.9 | ,, |
| 38.26 | 123.53 | 57.47 | 315.27 | 68.71 | 506.53 | Dreisbach and Shrader (1949) |
| 78.545 | 767.45 | 91.786 | 1268.50 | 100.832 | 1742.45 | Swietoslawski and Zlotowski |
| 86.101 | 1026.30 | 96.520 | 1500.00 | 103.320 | 1900.10 | ,, (1930) |
| 15 | 32.18 | | | | | Tower and Germann (1914) |
| 15 | 32.6 | | | | | Bachmann (1917) |
| 30 | 78.3 | | | | | Ferguson, Freed and Mooris (1933) |

*Boiling point*

| | | | |
|---|---|---|---|
| 78°2 | Schmidt (1891) | 78°32 | Lecat (passim) |
| 78°2 | Brown (1903) | 78°32 | (Mg) Frost (1930) |
| 78°20 | Kahlbaum (1883) | 78°35 | (Ca) ,, |
| 78°27 | Dreisbach and Martin (1949) | 78°325 | Wojciechowski (1936) |
| 78°3 | Piatti (1930–31) | 78°33 | Kretschmer and Wiebe (1949) |
| 78°3 | Marshall (1906) | 78°34 | Maryott (1941) |
| 78°3 | Richards and Davis (1920) | 78°35 | Dorochewsky and Poliansky (1910) |
| 78°3 | Merriman (1913) | 78°35 | Zepalova-Mikhaïlova (1937–39) |
| 78°3 | Maass and Boomer (1922) | 78°35 | Doulizkaya (1945) (99.98 %) |
| 78°3 | Young (1910) | 78°36 | Winkler (1905) |
| 78°3 | Rieder and Thompson (1949) | 78°4 | Mündel (1913) |
| 78°30 | Barbaudy (1927) | 78°4 | Faust (1912) |
| 78°32 | Brunel, Crenshaw and Tobin (1921) | 78°4 | Pollock, Collett and Lazzell (1946) |
| 78°32 | Tyrer (1914) | 78°41 | Dupre and Page (1869) |
| 78°32 | Grimm and Patrick (1923) | 78°42 | Richards and Coombs (1915) |
| 78°32 | Crafts (1887–1913) | | |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°3286 | Dreisbach and Martin (1949) | 0°334 | Wojciechowski (1936) |
| 0°33 | Crafts (1887–1913) | 0°34 | Dorochewsky and Poliansky (1910) |
| 0°332 | Merriman (1913) | 0°34 | Winkler (1905) |

*Freezing point:* −114°15 Timmermans (passim)
−114°49 Dreisbach and Martin (1949)

*Critical solution point:* in $CS_2$: −23°5 Maryott (1941)

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.80625 | Young (1910) | 15 | 0.79367 | Crismer (1904–6) |
| 10 | 0.7979 | „ | 20 | 0.78945 | „ |
| 20 | 0.7894 | „ | | | |
| | | | 0 | 0.80625 | Timmermans (1923) |
| 0 | 0.80625 | Mendelejeff (1869) | 0 | 0.80629 | Winkler (1905) |
| 5 | 0.80207 | „ | 5 | 0.80209 | „ |
| 10 | 0.79788 | „ | 10 | 0.79787 | „ |
| 15 | 0.79367 | „ | 15 | 0.79363 | „ |
| 20 | 0.78945 | „ | 20 | 0.78937 | „ |
| 25 | 0.78522 | „ | 25 | 0.78509 | „ |
| 30 | 0.78096 | „ | 30 | 0.78079 | „ |
| 0 | 0.806306 | Kretschmer, Nowakowska and Wiebe (1948) | 20 | 0.78934 | Solona and Moles (1932) |
| | | | 20 | 0.789344 | Riiber (1923) |
| 25 | 0.785063 | „ | 25 | 0.78503 | Lund and Bjerrum (1931) |
| 50 | 0.763137 | „ | 25 | 0.78505 | Brunel, Crenshaw and Tobin (1921) |
| 0 | 0.80628 | Merriman (1913) | 25 | 0.78506 | Robertson and Acree (1913) |
| 0 | 0.80629 | Wade and Merriman (1912) | 25 | 0.78506 | Osborne, Kelvy and Bearce (1913) |
| 15 | 0.793559 | Frost (1930) | | | |
| 15 | 0.79357 | Zepalova-Mikhaïlova (1939) | 25 | 0.78506 | Davis and Johnson (1918) |
| | | | 25 | 0.78506 | Barbaudy (1926) |
| 15 | 0.79367 | Dorochewsky (1911) | 25 | 0.78508 | Kretschmer and Wiebe (1949) |
| 17.5 | 0.79156 | Fresenius and Grunhut (1912) | 25 | 0.78510 | Andrews (1908) |
| | | | 25 | 0.78510 | Moesveld (1923) |

$d\,t° = 0.80625 - 84.5 \cdot 10^{-5}\,t° + 29 \cdot 10^{-8}\,t°^2$ (below 0°) Timmermans (1923)

*Viscosity*

| t° | $\eta \cdot 10^3$ | t° | $\eta \cdot 10^3$ | t° | $\eta \cdot 10^3$ | |
|---|---|---|---|---|---|---|
| 7.16 | 15.328 | 31.89 | 9.560 | 55.57 | 6.354 | THORPE and RODGER |
| 13.27 | 13.573 | 37.51 | 8.644 | 61.07 | 5.815 | „ (1894) |
| 19.22 | 12.094 | 42.84 | 7.875 | 67.53 | 5.263 | „ |
| 25.24 | 10.792 | 49.37 | 7.047 | 73.57 | 4.764 | „ |
| 30.00 | 9.91 | 78.27 | 4.42 | 120.00 | 2.47 | TITANI (1927) |
| 40.00 | 8.23 | 80.00 | 4.35 | 130.00 | 2.17 | „ |
| 50.00 | 7.01 | 90.00 | 3.76 | 140.00 | 1.93 | „ |
| 60.00 | 5.91 | 100.00 | 3.25 | 150.00 | 1.66 | „ |
| 70.00 | 5.03 | 110.00 | 2.85 | | | „ |
| 25 | 10.68 | GUY and JONES | | 14.53 | 13.17 | TOWER (1916) |
| 35 | 8.683 | „ (1911) | | 25 | 10.78 | HUGHES and HARTLEY (1933) and BARAK and HARTLEY (1933) |
| 45 | 7.292 | „ | | | | |
| 0 | 17.85 | WALDEN (1906) | | 25 | 10.8 | THOLE (1914) |
| 25 | 10.75 | „ | | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 22.76 | HENNAUT-ROLAND and LEK (1931) | 20 | 22.27 | RICHARDS and COOMBS (1915) |
| 20 | 22.32 | „ | 20 | 22.28 | ZEPALOVA-MIKHAÏLOVA (1937) |
| 30 | 21.48 | „ | 22 | 21.96 | TRIESCHMANN (1935) |
| 25 | 21.85 | LARSON and HERSCHEL HUNT (1939) | | | |

*Refractive index*

| t° | D | | t° | D | |
|---|---|---|---|---|---|
| 15° | 1.36330 | DOROCHEWSKY (1911) | 25° | 1.3595 | MUNCH (1926) |
| 15°5 | 1.36316 | HOLMES (1913) | 25° | 1.3596 | MÜLLER and GEURDJIKOFF (1912) |
| 20° | 1.36139 | SMYTH and STOOPS (1929) | 25° | 1.3596 | ERNST, WATKINS and RUWE (1936) |
| 20° | 1.3614 | POLLOCK, COLLETT and LAZZELL (1946) | 25°5 | 1.3595 | BRUNEL, CRENSHAW and TOBIN (1921) |
| 25° | 1.359408 | ANDREWS (1908) | | | |

*Dielectric constant*

| t° | $\varepsilon$ | | t° | $\varepsilon$ | |
|---|---|---|---|---|---|
| 0 | 27.88 | LE FEVRE (1938) | 45 | 21.53 | LE FEVRE (1938) |
| 10 | 26.41 | „ | 55 | 20.21 | „ |
| 20 | 25.00 | „ | 25 | 24.14 | LARSON and HERSCHEL HUNT (1939) |
| 25 | 24.25 | „ | | | |
| 35 | 22.79 | „ | | | |

## Heat constants

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|---|
| C. | −254.50 | 0.03162 | −218.90 | 0.1588 | −176.96 | 0.2390 | Kelley (1929) |
| | −251.16 | 0.04313 | −214.49 | 0.1688 | −173.10 | 0.2451 | (M.W. 46.05) |
| | −248.35 | 0.05688 | −210.54 | 0.1796 | −169.09 | 0.2525 | ,, |
| | −245.68 | 0.06932 | −206.95 | 0.1879 | −164.40 | 0.2585 | ,, |
| | −242.73 | 0.07888 | −203.24 | 0.1965 | −159.60 | 0.2666 | ,, |
| | −240.35 | 0.08748 | −200.01 | 0.2006 | −155.48 | 0.2718 | ,, |
| | −236.67 | 0.09918 | −195.59 | 0.2068 | −151.30 | 0.2796 | ,, |
| | −233.11 | 0.1107 | −191.45 | 0.2143 | −147.17 | 0.2839 | ,, |
| | −229.55 | 0.1249 | −187.63 | 0.2225 | −142.98 | 0.2861 | ,, |
| | −226.43 | 0.1382 | −183.05 | 0.2292 | −140.61 | 0.2915 | ,, |
| | −223.03 | 0.1485 | −180.65 | 0.2325 | | | ,, |
| L. | −109.65 | 0.4502 | −80.55 | 0.4615 | −13.60 | 0.5160 | ,, |
| | −105.26 | 0.4515 | −77.18 | 0.4617 | − 7.68 | 0.5212 | ,, |
| | −100.94 | 0.4532 | −75.82 | 0.4626 | − 2.14 | 0.5299 | ,, |
| | − 96.51 | 0.4548 | −65.03 | 0.4726 | + 4.36 | 0.5427 | ,, |
| | − 91.93 | 0.4593 | −60.22 | 0.4732 | 15.79 | 0.5625 | ,, |
| | − 87.59 | 0.4606 | −55.52 | 0.4826 | 21.15 | 0.5701 | ,, |
| | − 81.48 | 0.4611 | −34.97 | 0.4928 | | | ,, |
| C. | −186.1 | 0.231 | −173.1 | 0.251 | −143.1 | 0.296 | Parks (1925) |
| | −183.1 | 0.236 | −163.1 | 0.266 | −133.1 | 0.312 | ,, |
| | −178.1 | 0.244 | −153.1 | 0.281 | | | ,, |
| L. | −113.1 | 0.455 | − 33.1 | 0.507 | 16.9 | 0.572 | ,, |
| | − 73.1 | 0.468 | + 1.9 | 0.543 | 24.9 | 0.588 | ,, |
| | − 43.1 | 0.496 | | | | | ,, |
| L. | 30 | 0.603 | 45 | 0.653 | 60 | 0.705 | Blacet, Leighton |
| | 35 | 0.614 | 50 | 0.669 | 65 | 0.723 | and Bartlett |
| | 40 | 0.633 | 55 | 0.688 | 70 | 0.753 | ,, (1931) |

*Heat of vaporisation* cal 15°/g

| | | | | |
|---|---|---|---|---|
| 50° | 211.9 | 90° | 195.7 | Fiock, Ginnings and Holton (1931) |
| 70° | 204.5 | 110° | 185.9 | ,, |

*Heat of melting* cal 15°/g

| | | |
|---|---|---|
| −114°4 | 25.76 | Parks (1925) |
| −114°6 | 26.05 | Kelley (1929) |

| | | |
|---|---|---|
| *Heat of combustion* | 25° ($c_p$) 7092.9 cal 15° g | Rossini (1932) |

## *n*-PROPYL ALCOHOL $C_3H_7OH$

*n*-Propyl alcohol, obtained by a fermentation process, contains an impurity which cannot be eliminated without recrystallization in the form of a solid derivative: the phthalate. *n*-Propyl alcohol gives with water an azeotrope boiling 10° lower than the anhydrous alcohol. This compound can be dehydrated by distillation with a good dephlegmator (YOUNG, 1910), or by boiling with CaO (CRISMER, 1904) or Mg (LUND and BJERRUM, 1931). Criteria of purity are the density to the fifth figure (BRUNEL, 1923) and the critical temperature of solution in petroleum (CRISMER, 1904).

**Constants:** B.E. (1934). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 263.7 | 38120 | 0.2734 | YOUNG (1910) |

*Densities of the liquid and the saturated vapour:* YOUNG (1910)

| t° | L. | V. | t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|---|---|---|
| 80 | 0.7520 | 0.00104 | 150 | 0.6740 | 0.01060 | 220 | 0.5485 | 0.0556 |
| 90 | 0.7425 | 0.00156 | 160 | 0.6600 | 0.01380 | 230 | 0.5230 | 0.0704 |
| 100 | 0.7325 | 0.00226 | 170 | 0.6450 | 0.01770 | 240 | 0.4920 | 0.0904 |
| 110 | 0.7220 | 0.00320 | 180 | 0.6285 | 0.0225 | 250 | 0.4525 | 0.1180 |
| 120 | 0.7110 | 0.00443 | 190 | 0.6110 | 0.0282 | 260 | 0.3905 | 0.1610 |
| 130 | 0.6995 | 0.00605 | 200 | 0.5920 | 0.0353 | 263.15 | 0.3450 | — |
| 140 | 0.6875 | 0.00805 | 210 | 0.5715 | 0.0442 | 263.5 | 0.3380 | — |

*Rectilinear diameter:* $0.4095 - 379 \cdot 10^{-6}\, t° - 375 \cdot 10^{-9}\, t°^2 - 5533 \cdot 10^{-13}\, t°^3$
YOUNG (1900—10)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −15.7 | 1.036 | −23.1 | 0.549 | −29.7 | 0.295 | Mündel (1913) |
| −18.4 | 0.815 | −26.2 | 0.403 | −43.3 | 0.0068 | „ |
| 0 | 3.44 | 100 | 842.5 | 200 | 12801 | Young (1910) |
| 10 | 7.26 | 110 | 1206 | 210 | 15575 | „ |
| 20 | 14.5 | 120 | 1683 | 220 | 18679 | „ |
| 30 | 27.6 | 130 | 2293 | 230 | 22154 | „ |
| 40 | 50.2 | 140 | 3074 | 240 | 26194 | „ |
| 50 | 87.2 | 150 | 4052 | 250 | 30785 | „ |
| 60 | 147.0 | 160 | 5264 | 260 | 36103 | „ |
| 70 | 239.0 | 170 | 6695 | 263.7 | 38120 | „ |
| 80 | 376.0 | 180 | 8383 | | | „ |
| 90 | 574.0 | 190 | 10466 | | | „ |
| 2.3 | 4.59 | 35.1 | 39.81 | 59.7 | 143.0 | Richardson (1886) |
| 4.8 | 5.19 | 36.7 | 40.81 | 62.5 | 163.96 | „ |
| 6.2 | 5.78 | 38.2 | 45.50 | 66.2 | 214.75 | .. |
| 10.8 | 7.84 | 39.2 | 47.40 | 68.7 | 220.74 | „ |
| 11.45 | 8.56 | 41.7 | 54.88 | 74.5 | 287.3 | „ |
| 11.7 | 8.83 | 43.7 | 61.67 | 75.2 | 300.67 | „ |
| 13.2 | 9.49 | 44.7 | 65.21 | 79.2 | 358.75 | „ |
| 14.9 | 10.96 | 46.7 | 73.50 | 81.9 | 400.67 | „ |
| 20.7 | 15.46 | 48.7 | 85.53 | 85.7 | 477.51 | „ |
| 23.7 | 18.82 | 53.9 | 106.92 | 90.2 | 566.22 | „ |
| 28.2 | 24.96 | 55.7 | 119.25 | 94.1 | 711.01 | „ |
| 30.6 | 29.04 | 56.5 | 129.23 | 97.2 | 746.45 | „ |
| 33.8 | 34.90 | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 97°1 | Mündel (1913) | 97°19 | Grimm and Patrick (1923) |
| 97°15 | B.E. (1934) | 97°2 | Lecat (passim) |
| 97°15 | Zepalova-Mikhaïlova (1937) | 97°20 | Dorochewsky (1909) |
| 97°175 | Brunel (1923) | 97°209 | Wojciechowski (1936) |
| 97°19 | Young and Fortey (1903) | 97°26 | Dorochewsky (1911) |
| 97°19 | Carley and Bertelsen (1949) | | |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°38 | B.E. (1934) | 0°37 | Lecat (passim) |

*Freezing point:* —126°1 Parks and Huffman (1926)

## Constants of state

*Density*

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| 20 | 0.8035 | 40 | 0.7875 | 60 | 0.7700 | Young (1910) |
| 30 | 0.7960 | 50 | 0.7785 | 70 | 0.7610 | „ |

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.81920 | B.E. (1934) | 0 | 0.81926 | Timmermans (1923) |
| 15 | 0.80749 | „ | 0 | 0.81923 | Young and Fortey (1902) |
| 30 | 0.79567 | „ | 17 | 0.8061 | Schmidt (1926) |
| 20 | 0.8035 | Lowry (1914) | 25 | 0.79968 | Holmes and Sageman (1909) |
| 20 | 0.8035 | Hatem (1949) | 25 | 0.79985 | Brunel (1923) |
| 20 | 0.80357 | Zepalova-Mikhaïlova (1937) | 25 | 0.7999 | Parks and Huffman (1926) |
| 20 | 0.80358 | Crismer (1904) | | | |

$d\,t° = 0.81926 - 76.9 \cdot 10^{-5}\,t° + 65 \cdot 10^{-8}\,t°^2$ (at low temperatures) Timmermans (1923)

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2522 | B.E. (1934) |
| 30 | 1722 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 24.09 | B.E. (1934) | 20 | 23.78 | Brown (1932) |
| 20 | 23.70 | „ | 20 | 23.73 | Zepalova-Mikhaïlova (1937) |
| 30 | 22.89 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.38470 | 1.38501 | — | 1.38706 | 1.39081 | 1.39178 | 1.39473 | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00037 | 37 | — | 38 | 39 | 39 | 40 | „ |
| 23.6 | 1.3818 | — | 1.3840 | — | — | — | — | Beynon (1941) |

Values for other wavelengths are given by Beynon (1941)

**Heat constants**

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −184.8 | 0.207 | −166.1 | 0.237 | −151.0 | 0.261 | Parks and Huffman |
| −178.9 | 0.216 | −159.8 | 0.246 | −150.3 | 0.262 | „ (1926) |
| −172.9 | 0.226 | −159.5 | 0.246 | −145.4 | 0.272 | „ |
| −172.0 | 0.227 | | | | | „ |
| L. −120.5 | 0.425 | −79.0 | 0.442 | −71.5 | 0.447 | „ |
| −104.0 | 0.430 | −74.1 | 0.444 | + 1.9 | 0.531 | „ |
| − 87.5 | 0.436 | | | | | „ |
| L. 3.52 | 0.5332 | 27.32 | 0.5755 | 41.91 | 0.5983 | Bose (1906—7) |

| | | |
|---|---|---|
| *Heat of vaporisation* | 179.9 cal 15°/g | Bartoszewiczowna (1931) |
| *Heat of melting* | 20.66 „ | Parks and Huffman (1926) |

## *Iso*-PROPYL ALCOHOL $(CH_3)_2.CHOH$

*Iso*-propyl alcohol gives with water an azeotrope, having a boiling point 2° lower than the pure alcohol; dehydration by fractional distillation is thus a rather delicate and wasteful operation. Addition of benzene followed by distillation leads to complete elimination of water as a ternary azeotrope boiling at 66°5. The excess of benzene distils at 71°9 giving also an azeotrope with isopropyl alcohol (Young and Fortey, 1902). The alcohol can also be dehydrated by boiling over lime or baryta.

**Constants:** B.E. (1934)

*Critical temperature:* 243°47 Brown (1906)

*Saturated vapour pressure:* Parks and Barton (1928)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 0.00 | 8.9 | 25.00 | 44.0 | 50.00 | 176.8 | 75.00 | 561.4 |
| 5.00 | 12.1 | 30.00 | 59.1 | 55.00 | 227.4 | 80.00 | 691.8 |
| 10.00 | 17.0 | 35.00 | 78.9 | 60.00 | 288.5 | 85.00 | 845.6 |
| 15.00 | 23.8 | 40.00 | 105.6 | 65.00 | 363.1 | 90.00 | 1020.7 |
| 20.00 | 32.4 | 45.00 | 136.8 | 70.00 | 454.8 | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 82°2 | Ginnings and Corruccini (1948) | 82°4 | Clough and Jones (1923) |
| 82°258 | Brunel (1923) | 82°40 | B.E. (1934) |
| 82°26 | Brunel, Crenshaw and Tobin (1921) | 82°42 | Lecat (passim) |
| 82°29 | Swietoslawski (1934) | 82°44 | Young and Fortey (1902) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°33 | Brunel, Crenshaw and Tobin (1921) | 0°35 | B.E. (1934) and Lecat (passim) |

*Freezing point:* −89°5 B.E. (1934)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.80136 | B.E. (1934) | 25 | 0.78084 | Brunel (1923) |
| 15 | 0.78916 | ,, | 25 | 0.78086 | Parks and Kelley (1925) |
| 30 | 0.77690 | ,, | 25 | 0.78087 | Olsen and Washburn (1935) |
| 0 | 0.80120 | Young and Fortey (1902) | 25 | 0.78091 | Parks and Barton (1928) |
| 20 | 0.78512 | Zepalova-Mikhaïlova (1937) | 25 | 0.78095 | Kelley (1929) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2859 | B.E. (1934) |
| 30 | 1765 | ,, |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 21.79 | B.E. (1934) |
| 20 | 21.35 | ,, |
| 30 | 20.96 | ,, |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.37688 | 1.37719 | 1.37913 | 1.38288 | 1.38375 | 1.38679 | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00034 | 34 | 34 | 34 | 34 | 34 | ,, |
| 20 | — | — | 1.3775 | — | — | — | Fischer and Reichel (1943) |

*Specific heat:* Ginnings and Corruccini (1948)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| 0 | 0.541 | 40 | 0.670 | 100 | 0.848 | 160 | 0.983 |
| 20 | 0.596 | 60 | 0.742 | 120 | 0.894 | 180 | 1.024 |
| | | 80 | 0.798 | 140 | 0.939 | 200 | 1.062 |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 20° | 175.6 cal 15° g | Bartoszewiczowna (1931) |
| *Heat of melting* | −88°43 | 21.37 ,, | Kelley (1929) |

## *n*-BUTYL ALCOHOL $C_4H_9OH$

*n*-Butyl alcohol only became an easily available material thirty years ago. This alcohol is easily dehydrated by fractional distillation since its azeotrope with water boils 26° lower than the alcohol itself.

**Constants:** B.E. (1928). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | |
|---|---|---|
| 287.0 | 36775 | Herz and Neukirsch (1923) |

*Saturated vapour pressure:* KAHLBAUM (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 15.1 | 3 | 40.6 | 19 | 50.6 | 35 | 58.6 | 55 |
| 18.7 | 4 | 41.5 | 20 | 51.1 | 36 | 60.2 | 60 |
| 21.7 | 5 | 42.2 | 21 | 51.5 | 37 | 61.6 | 65 |
| 24.0 | 6 | 42.9 | 22 | 52.0 | 38 | 63.0 | 70 |
| 26.1 | 7 | 43.6 | 23 | 52.5 | 39 | 64.3 | 75 |
| 27.9 | 8 | 44.3 | 24 | 52.9 | 40 | 69.8 | 100 |
| 29.5 | 9 | 45.0 | 25 | 53.4 | 41 | 78.1 | 150 |
| 31.0 | 10 | 45.6 | 26 | 53.8 | 42 | 84.3 | 200 |
| 32.4 | 11 | 46.2 | 27 | 54.2 | 43 | 89.4 | 250 |
| 33.6 | 12 | 46.8 | 28 | 54.6 | 44 | 93.7 | 300 |
| 34.8 | 13 | 47.4 | 29 | 55.0 | 45 | 97.4 | 350 |
| 35.9 | 14 | 48.0 | 30 | 55.4 | 46 | 100.8 | 400 |
| 36.9 | 15 | 48.6 | 31 | 55.8 | 47 | 103.7 | 450 |
| 37.9 | 16 | 49.1 | 32 | 56.1 | 48 | 106.3 | 500 |
| 38.9 | 17 | 49.6 | 33 | 56.5 | 49 | 108.8 | 550 |
| 39.7 | 18 | 50.1 | 34 | 56.9 | 50 | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 117°7 | BRUNJES and FURNAS (1935) | 117°8 | ALLEN, LINGO and FELSING (1939) |
| 117°7 | VERKADE and COOPS (1927) | 117°8 | BRUNJES and BOGART (1943) |
| 117°71 | GRIMM and PATRICK (1923) | 118°0 | B.E. (1928) |
| 117°726 | WOJCIECHOWSKI (1936) | 118°0 | KEFFLER and MAC LEAN (1935) |
| 117°8 | LECAT (passim) | 118°0 | ZEPALOVA-MIKHAÏLOVA (1939) |

*$\frac{dt}{dp}$ (10 mm)*

| | | | |
|---|---|---|---|
| 0°36 | LECAT (passim) | 0°372 | WOJCIECHOWSKI (1936) |
| 0°37 | B.E. (1928) | | |

*Freezing point:* −89°8 TIMMERMANS (passim)

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.82472 | B.E. (1928) | 0 | 0.8246 | JONES and CHRISTIAN |
| 15 | 0.81337 | „ | 25 | 0.80572 | „ (1938) |
| 30 | 0.80206 | „ | | | |
| 15.5 | 0.8130 | EYKMAN (1893–1919) | 25 | 0.8057 | ALLEN, LINGO and FELSING (1939) |
| 20 | 0.80961 | ZEPALOVA-MIKHAÏLOVA (1937) | 25 | 0.8057 | LARSON, and HERSCHEL HUNT (1939) |
| 25 | 0.80567 | BRUNJES and BOGART (1943) | 34.6 | 0.7986 | VERKADE and COOPS (1927) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 3379 | B.E. (1928) |
| 30 | 2271 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 25.00 | Hennaut-Roland and Lek |
| 20 | 24.57 | „ (1931) |
| 30 | 23.75 | „ |
| 25 | 24.2 | Larson and Herschel Hunt (1931) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.39886 | 1.39913 | 1.40118 | 1.40130 | 1.40521 | 1.40612 | 1.40904 | 1.40997 | B.E. (1928) |
| $\frac{dn}{dt}$ | — | 0.00039 | 39 | — | — | 40 | — | 40 | „ |
| 25 | — | — | 1.3974 | — | — | — | — | — | Allen, Lingo and Felsing (1939) |
| 25 | — | — | 1.3970 | — | — | — | — | — | Brunjes and Bogart (1943) |

**Heat constants**

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 20° | 149.4 cal 15°/g | Bartoszewiczowna (1931) |
| *Heat of melting* | | 29.93 „ | Parks (1925) |

## *Iso*-BUTYL ALCOHOL $(CH_3)_2CH.CH_2OH$

This is easily obtained pure and water-free by fractional distillation since it gives, with water, a azeotrope boiling 18° lower than the alcohol itself.

**Constants:** B.E. (1928) — **Polyphasic equilibria**

*Critical temperature:* 279°07 Brown (1906)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 14.75 | 5.8 | 50.45 | 55.5 | 70.7 | 160.65 | 91.0 | 395.2 | Konovalow |
| 30.85 | 17.7 | 60.4 | 94.1 | 80.0 | 246.0 | 99.9 | 570.3 | (1881) |

*Satured vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 25.3 | 11.212 | 61.3 | 98.68 | 75.9 | 204.06 | 91.55 | 399.35 | Richardson |
| 32.8 | 18.44 | 62.3 | 103.043 | 77.2 | 213.77 | 92.8 | 418.12 | „ (1886) |
| 35.4 | 21.426 | 65.8 | 123.920 | 78.7 | 229.45 | 92.95 | 428.94 | „ |
| 37.9 | 26.160 | 66.0 | 124.617 | 81.3 | 259.001 | 95.40 | 468.978 | „ |
| 42.0 | 33.123 | 67.75 | 134.85 | 83.6 | 284.30 | 95.8 | 478.117 | „ |
| 46.7 | 44.069 | 69.9 | 151.20 | 84.8 | 297.587 | 98.05 | 524.86 | „ |
| 50.8 | 55.666 | 71.8 | 166.62 | 85.3 | 304.47 | 100.7 | 575.651 | „ |
| 52.8 | 62.68 | 73.8 | 182.38 | 87.3 | 332.32 | 101.55 | 593.86 | „ |
| 54.9 | 71.61 | 74.8 | 194.68 | 90.3 | 378.12 | 102.75 | 626.264 | „ |
| 58.8 | 85.86 | | | | | 104.8 | 669.113 | „ |
| | | | | | | 105.8 | 708.36 | „ |
| 20 | 8.8 | — | — | — | — | — | — | Faust (1912) |

*Boiling point*

| | | | |
|---|---|---|---|
| 107°89 | Brunel, Crenshaw and Tobin (1921) | 107°98 | Allen, Lingo and Felsing (1939) |
| 107°894 | Bylewski (1932) | 108°01 | Lecat |
| 107°93 | Dorochewsky and Dworzancyck (1908) | 108°06 | Young and Fortey (1902) |
| | | 108°10 | B.E. (1928) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°35 | B.E. (1928) | 0°36 | Lecat |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.81707 | B.E. (1928) | 0 | 0.81698 | Young and Fortey (1902) |
| 15 | 0.80576 | „ | 16.35 | 0.80459 | „ |
| 30 | 0.79437 | „ | | | |
| 15 | 0.80563 | Dorochewsky (1909–11) | 25 | 0.7982 | Allen, Lingo and Felsing (1939) |
| 19.8 | 0.8021 | Hückel and Ackerman (1932) | 25.6 | 0.7977 | Eykman (1919) |
| 20 | 0.80196 | Bylewski (1932) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 4703 | B.E. (1928) |
| 30 | 2876 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 23.42 | Hennaut-Roland and Lek (1931) |
| 20 | 22.98 | „ |
| 30 | 22.11 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.39554 | 1.39569 | 1.39768 | 1.39785 | 1.40190 | 1.40270 | 1.40581 | 1.40679 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00038 | 38 | 39 | 39 | 39 | 39 | 40 | 40 | „ |
| 15 | — | — | 1.39750 | — | — | — | — | — | Dorochewsky (1911) |
| 20 | — | — | 1.3959 | — | — | — | — | — | Longinow and Prjanischnikow (1931) |
| 25 | — | — | 1.3939 | — | — | — | — | — | Allen, Lingo and Felsing (1939) |
| 25.6 | 1.39167 | 1.39194 | 1.39750 | 1.39396 | 1.39779 | 1.39872 | 1.40149 | 1.40258 | Eykman (1919) |

**Heat constants**

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 20° | 147.1 cal 15°/g | Bartoszcewiczowna (1931) |

## *sec*-BUTYL ALCOHOL $CH_3.CH_2.CHOH.CH_3$

This compound has been studied thoroughly by Timmermans and his co-workers on account of the particular characters shown by its curve of solubility in water; and by Pickard and Kenyon, for the rotatory power of its optical antipodes.

The technical product is obtained by catalytic reduction of methylethylketone. It forms an azeotrope with water, which boils 11° lower than the pure alcolhol. A careful fractional distillation yields the alcohol pure and dry; the samples obtained in this way show the same density for a series of successive fractions and the properties of the latter do not alter either when regenerated after having been transformed into acid phthalate or after treatment with lime.

The constants of the racemic compound are identical with those of the optical antipodes.

**Constants:** B.E. (1928)

*Critical temperature:* 265°19 BROWN (1906)

*Saturated vapour pressure:* ROLAND (1928)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 0.32 | 2.8 | 12.0 | 7.1 | 20.05 | 12.7 | 39.9 | 44.6 |
| 9.68 | 6.4 | 15.22 | 9.1 | 29.98 | 24.2 | 49.7 | 79.5 |

*Boiling point*

| | | | |
|---|---|---|---|
| 99°5 | TIMMERMANS (1911) | 99°50 | $\frac{dt}{dp}$ *(10 mm):* 0°40 B.E. (1928) |
| 99°5 | HOUSTON (1933) | 99°52 | „ 0°39 LECAT (passim) |

*Density* *Viscosity* *Surface tension*

| t° | d. (active) | d. (racemic) | t° | $\eta \cdot 10^5$ | t° | $\gamma$ |
|---|---|---|---|---|---|---|
| 0 | 0.82275 | 0.82273 | 15 | 4210 | 15 | 23.89 |
| 15 | 0.81088 | 0.81089 | 30 | 3180 | 20 | 23.47 |
| 30 | 0.79895 | 0.79898 | | | 30 | 22.62 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | — | 1.39730 | 1.39946 | 1.39946 | — | 1.40434 | — | 1.40835 | B.E. (1928) |
| $\frac{dn}{dt}$ | — | 0.00046 | 49 | 49 | — | 48 | — | 49 | „ |
| 19.1 | 1.39511 | 1.39539 | — | 1.39743 | 1.40126 | 1.40218 | 1.40494 | 1.40604 | EYKMAN (1919) |

*Rotatory power*

| t° | Li r. | Li or. | Na | He y. | Hg g. | Li bl. | Hg v. | |
|---|---|---|---|---|---|---|---|---|
| 20 | 10.50 | 12.84 | 13.87 | 14.45 | 16.36 | 23.94 | 27.14 | B.E. (1928) |

## TRIMETHYLCARBINOL or *tert*-BUTYL ALCOHOL $C(CH_3)_3OH$

This is purified by alternate fractional freezing and fractional distillation. It gives a constant-boiling mixture with water, but the boiling point of the mixture (79°9) is so near to that of the pure alcohol (82°45), that it is best purified by fractional distillation in the presence of benzene (YOUNG and FORTEY, 1902).

The melting point and density constitute the best criteria of purity.

### Constants: B.E. (1934). — Polyphasic equilibria

*Saturated vapour pressure*: PARKS and BARTON (1928)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 20.00 | 30.6 | 45.00 | 133.8 | 70.00 | 447.3 |
| 25.00 | 42.0 | 50.00 | 174.3 | 75.00 | 553.2 |
| 30.00 | 56.9 | 55.00 | 224.2 | 80.00 | 679.4 |
| 35.00 | 76.3 | 60.00 | 285.2 | 85.00 | 826.3 |
| 40.00 | 102.3 | 65.00 | 358.2 | 90.00 | 996.2 |

*Boiling point*

| | | | |
|---|---|---|---|
| 82°45 | LECAT (passim) | 82°55 | SWARTS (1929) |
| 82°50 | B.E. (1934) | 82°57 | DOROCHEWSKY (1911) |
| 82°55 | YOUNG and FORTEY (1902) | $\frac{dt}{dp}$ *(10 mm)*: 0°29 B.E. (1934) | |

*Melting point*

| | | | |
|---|---|---|---|
| 25°4 | PARKS and ANDERSON (1926) | 25°53 | YOUNG and FORTEY (1902) |
| 25°45 | DE FORCRAND (1903) | 25°55 | B.E. (1934) |
| 25°5 | MARSDEN and EVANS (1937) | 25°66 | SIMONSEN and WASHBURN (1946) |
| 25°50 | PARKS and BARTON (1928) | 25°00 | (second cryst. form) ,, |

### Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 0.78670 | B.E. (1934) | 22 | 0.78462 | SPELLS (1936) |
| 30 | 0.77620 | ,, | 27.1 | 0.7791 | EYKMAN (1919) |
| 35 | 0.77090 | ,, | 27.2 | 0.7792 | SWARTS (1929) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 30 | 3316 | B.E. (1934) |
| 35 | 2575 | „ |
| 40 | 2039 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 20.02 | B.E. (1934) |
| 20 | 19.56 | „ |
| 30 | 19.10 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 25 | 1.38286 | 1.38315 | 1.38520 | 1.38912 | 1.38996 | 1.39296 | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00048 | 48 | 49 | 49 | 49 | 50 | „ |
| 27 | 1.38196 | — | 1.38426 | 1.38802 | — | 1.39169 | MARSDEN and EVANS (1937) |

For other wavelengths, see: MARSDEN and EVANS (1937)

**Heat constants**

*Specific heat:* PARKS and ANDERSON (1926)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −186.06 | 0.178 | −167.06 | 0.207 | −112.46 | 0.290 | −69.66 | 0.362 |
| −179.96 | 0.188 | −164.96 | 0.210 | − 80.16 | 0.342 | −57.16 | 0.385 |
| −173.36 | 0.198 | −160.86 | 0.216 | − 76.46 | 0.349 | −44.86 | 0.408 |
| −170.66 | 0.200 | −119.66 | 0.282 | − 73.46 | 0.354 | −29.76 | 0.443 |
| L. + 26.9 | 0.725 | + 27.2 | 0.728 | — | — | — | — |

## *n*-AMYL ALCOHOL $C_5H_{11}OH$

This alcohol is obtained in a pure state only by synthesis. This involves the reaction between trioxymethylene (or gaseous formaldehyde) and *n*-butyl-magnesium bromide. Fractional distillation gives a pure product, yet all the old samples were impure.

**Constants** B.E. (1932)

*Boiling point*

| | |
|---|---|
| 137°95 | LIEVENS (1924) |
| 138°00 | SIMON (1929) |
| 138°06 | WOJCIECHOWSKI (1936) |
| 138°2 | LECAT (passim) |
| 138°25 | B.E. (1932) |
| $\frac{dt}{dp}$ (10 mm) | 0°37 B.E. (1932) and SIMON (1929) |

*Freezing point:* −78°85 B.E. (1932)

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.82897 | B.E. (1932) and Simon |
| 15 | 0.81837 | „ „ (1929) |
| 30 | 0.80764 | „ „ |
| 34.6 | 0.8041 | Verkade and Coops (1927) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 4650 | B.E. (1932) and Simon |
| 30 | 2987 | „ (1929) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 26.03 | B.E. (1932) and Hennaut-Roland and Lek (1931) |
| 20 | 25.60 | „ |
| 30 | 24.72 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40930 | 1.40955 | 1.41173 | 1.41185 | 1.41580 | 1.41674 | 1.41990 | 1.42111 | B.E. (1932) and Simon |
| $\frac{dn}{dt}$ | 0.00036 | 35 | 35 | 36 | 37 | 36 | 37 | 37 | „ (1929) |

## *Active* AMYL ALCOHOL or *sec*-BUTYLCARBINOL $\begin{matrix} C_2H_5 \\ CH_3 \end{matrix}\!\!>\!CH\text{—}CH_2OH$

This compound is obtained from amyl alcohol by a fermentation process and fractional crystallization of a suitable ester such as the trinitrophthalate.

**Constants:** Marckwald and Mac Kenzie (1901)

*Boiling point:* 128°

*Specific rotatory power*

| λ | 665.9 | 589.2 | 532.0 | 488.5 | 448.2 |
|---|---|---|---|---|---|
| 20° | −4.42 | −5.90 | −7.44 | −8.03 | −11.76 |

## *Iso*-AMYL ALCOHOL or *iso*-BUTYLCARBINOL $(CH_3)_2CH.CH_2.CH_2OH$

Most authors have obtained a relatively impure product by the fractionation of fusel oil; the only satisfactory synthesis consists in allowing trioxymethylene to react with pure *iso*-butyl-magnesium bromide.

**Constants:** TIMMERMANS and HENNAUT-ROLAND (1929)

*Critical temperature:* 309°77 BROWN (1906)

*Boiling point*

| | |
|---|---|
| 131°9 | $\frac{dt}{dp}$ *(10 mm):* 0°34 LECAT (passim) |
| 132°0 | „ 0°30 TIMMERMANS and HENNAUT-ROLAND (1929) |
| 132°05 | YOUNG and FORTEY (1902) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.82392 | TIMMERMANS and HENNAUT- | 0 | 0.8238 | BALBIANO (1876) |
| 15 | 0.81294 | „ ROLAND (1929) | 15 | 0.81282 | PERKIN (1884) |
| 30 | 0.80179 | „ | 25 | 0.80540 | „ |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 4811.1 | TIMMERMANS and HEN- | 15 | 24.77 | TIMMERMANS and HEN- |
| 30 | 2961 | NAUT-ROLAND (1929) | 20 | 24.32 | NAUT-ROLAND (1929) |
| | | | 30 | 23.44 | „ |

*Refractive index*

| t° | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|
| 15 | 1.40633 | 1.40851 | 1.41240 | 1.41352 | 1.41648 | 1.41783 | TIMMERMANS and HENNAUT-ROLAND (1929) |
| $\frac{dn}{dt}$ | 1.00036 | 37 | — | 38 | — | 40 | „ |
| 22.1 | 1.4038 | — | — | — | — | — | BARBIER and ROUX (1890) |

*Magnetic rotatory power:* 18°6 0.9891 PERKIN (1884)

## *Sec*-AMYL ALCOHOL or METHYLPROPYLCARBINOL $\begin{matrix} C_3H_7 \\ CH_3 \end{matrix}\!\!>\!\!CHOH$

This substance is prepared from acetaldehyde and *n*-propyl-magnesium bromide. Paraldehyde (b.p.: 124°) forms an azeotrope (118°5) which is difficult to separate; the alcohol is unstable at the boiling point.

**Constants:** B.E. (1912)

*Boiling point*

| | | | | |
|---|---|---|---|---|
| 119°8 | LECAT (passim) | 119°85 | $\frac{dt}{dp}$ | *(10 mm)*: 0°39 B.E. (1932) |

*Density*

| t° | d |
|---|---|
| 0 | 0.82470 |
| 15 | 0.81319 |
| 30 | 0.80120 |

*Viscosity*

| t° | $\eta \cdot 10^4$ |
|---|---|
| 15 | 513 |
| 30 | 278 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 24.42 |
| 20 | 23.98 |
| 30 | 22.96 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.40592 | 1.40629 | 1.40851 | 1.41244 | 1.41345 | 1.41659 |
| $\frac{dn}{dt}$ | 0.00041 | 41 | 41 | 42 | 43 | 44 |

## *Tert*-AMYL ALCOHOL or DIMETHYLETHYLCARBINOL $\begin{matrix} (CH_3)_2 \\ C_2H_5 \end{matrix}\!\!>\!\!COH$

**Constants:** B.E. (1932)

*Critical temperature:* 271°77 BROWN (1906)

*Boiling point*

| | | | | |
|---|---|---|---|---|
| 102°27 | PARKS, HUFFMAN and BARMORE (1933) | 102°35 | $\frac{dt}{dp}$ | *(10 mm)*: 0°37 B.E. (1932) |
| 102°32 | ATKINS and WALLACE (1913) | 102°35 | „ | 0°36 LECAT (passim) |

*Freezing point*

| | |
|---|---|
| −8°6 | B.E. (1932) |
| −9°1 | PARKS, HUFFMAN and BARMORE (1933) |

*Density*

| t° | d |
|---|---|
| 0 | 0.82718 |
| 15 | 0.81346 |
| 30 | 0.79974 |

*Viscosity*

| t° | $\eta \cdot 10^4$ |
|---|---|
| 15 | 548 |
| 30 | 281 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 23.22 |
| 20 | 22.77 |
| 30 | 21.84 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.40468 | 1.40495 | — | 1.40726 | 1.41126 | 1.41226 | 1.41526 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00043 | 42 | — | 43 | 43 | 43 | 45 | „ |
| 25 | — | — | 1.4020 | — | — | — | — | MUNCH (1926) |

## DIETHYLCARBINOL $(C_2H_5)_2CHOH$

**Constants:** B.E. (1932)

*Boiling point*

| | |
|---|---|
| 116°0 | LECAT (passim) |
| 116°10 | $\frac{dt}{dp}$ *(10 mm):* 0°35 B.E. (1932) |

*Density*

| t° | d |
|---|---|
| 0 | 0.83681 |
| 15 | 0.82466 |
| 30 | 0.81180 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 7337 |
| 30 | 3306 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 25.02 |
| 20 | 24.60 |
| 30 | 23.76 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.40992 | 1.41026 | 1.41249 | 1.41639 | 1.41743 | 1.42049 |
| $\frac{dn}{dt}$ | 0.00046 | 45 | 46 | 47 | 46 | 48 |

## *n*-HEXYL ALCOHOL $n\text{-}C_6H_{13}OH$

Prepared by reducing ethyl caproate with sodium in absolute alcohol.

### Constants

*Boiling point*

| | | |
|---|---|---|
| 157°47 | $\frac{dt}{dp}$ *(10 mm)*: 0°39 | BILTERYS (1935) |
| 157°85 | | LECAT (passim) |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.83285 | BILTERYS (1935) |
| 15 | 0.82239 | „ |
| 30 | 0.81201 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 6203 | BILTERYS (1935) |
| 30 | 3872 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 24.94 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 24.48 | „ |
| 30 | 23.68 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | |
|---|---|---|---|---|---|---|
| 15 | 1.41685 | 1.41722 | 1.41935 | 1.42338 | 1.42434 | BILTERYS (1935) |
| $\frac{dn}{dt}$ | 0.00035 | 34 | 34 | 34 | 34 | „ |

*Specific heat:* KELLEY (1929)

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | | t° | $c_p$ |
|---|---|---|---|---|---|---|---|---|---|
| C. | −254.88 | 0.01512 | −212.19 | 0.1131 | −152.85 | 0.2001 | L. | −43.52 | 0.4170 |
| | −246.05 | 0.03406 | −206.83 | 0.1239 | −144.50 | 0.2128 | | −32.97 | 0.4287 |
| | −242.44 | 0.04265 | −202.15 | 0.1318 | −136.38 | 0.2204 | | −22.43 | 0.4354 |
| | −237.80 | 0.05444 | −196.64 | 0.1409 | −127.34 | 0.2299 | | −12.46 | 0.4460 |
| | −232.75 | 0.06666 | −187.78 | 0.1548 | −119.07 | 0.2395 | | − 2.59 | 0.4678 |
| | −228.24 | 0.07733 | −178.57 | 0.1668 | −110.51 | 0.2465 | | + 7.40 | 0.4886 |
| | −223.97 | 0.08687 | −169.90 | 0.1779 | −101.47 | 0.2543 | | 12.85 | 0.4956 |
| | −217.34 | 0.1015 | −161.62 | 0.1894 | − 92.30 | 0.2655 | | | |

| | | |
|---|---|---|
| *Heat of melting* | −47°3 36.00 cal 15°/g | KELLEY (1929) |

HOVORKA, LANKELMA and STANFORD (1938); HOVORKA, LANKELMA and AXEBROD (1940); HOVORKA, LANKEMA and SMITH (1940); HOVORKA, LANKELMA and BISHOP (1941), have studied different hexylic alcohols.

3-METHYL-PENTANOL-3 $CH_3 . CH_2 . C(CH_3)OH . CH_2 . CH_3$
2,3-DIMETHYL-BUTANOL-2 $CH_3 . C(CH_3)OH . CH(CH_3) . CH_3$

Boiling and freezing points, density and refractive index: see HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947).

### *n*-HEPTYL ALCOHOL $n$-$C_7H_{15}OH$

Prepared by catalytic hydrogenation of oenanthol. The values of BILTERYS (1935), DEFFET (1931) and SHERRILL (1930), although close, do not agree.

## THE HIGHER ALCOHOLS AND THEIR ISOMERS

EYKMAN in his „*Refractometrical Researches*" has determined a series of constants: boiling point under reduced pressure and freezing point, density and refractive index (for eight different wave-lengths) at one temperature; he did this for a great number of these alcohols. The samples appear to have been pure, but the information which the author has left is insufficient and there can be no absolute certainty as to the accuracy of his constants.

PICKARD and KENYON (1907–11) have prepared a series of optically active secondary alcohols. Their samples appear to have been carefully purified. Other authors e.g. LOWRY and RICHARDS (1924), have used the same sample of secondary octyl alcohol (methylhexyl carbinol). SMITH (1914) has repeated the preparation, but he obtained different results. Moreover the results given by BINGHAM and DARRAL (1930) also disagree with the others.

Recently, PATTERSON and HOLMES (1936) carefully studied the octyl alcohols. In the paper by BINGHAM and DARRAL, there is a series of constants concerning the isomers but, once again, there are insufficient indications of the degree of purity of the samples.

For *n*-octyl alcohol and methyl-hexyl carbinol, where comparison data exist, there are discrepancies. The same remarks hold for the values of the viscosities given by BINGHAM and STEPHENS (1933) for a series of higher isomeric alcohols.

### *n*-OCTYL ALCOHOL $n$-$C_8H_{17}OH$

DEFFET (1931) obtained his sample by GRIGNARD's synthesis using *n*-heptyl iodide and formaldehyde.

**Constants**

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 195°2 | LECAT (passim) | −16°7 | TIMMERMANS |
| 194°45 | DEFFET (1931) | | |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.84216 | DEFFET (1931) |
| 15 | 0.83202 | „ |
| 30 | 0.82192 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 10640 | DEFFET (1931) |
| 30 | 6125 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 26.50 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 26.06 | „ |
| 30 | 25.21 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42948 | 1.42983 | 1.43230 | 1.43670 | 1.43772 | 1.44096 | 1.44198 | DEFFET (1931) |
| $\frac{dn}{dt}$ | 0.00040 | 40 | 40 | 41 | 40 | 41 | 41 | „ |

DI-*iso*-BUTYLCARBINOL $[(CH_3)_2CH.CH_2]_2CHOH$: STROSS, GABLE and ROUNDS (1947).
Other alcohols in $C_9$ and $C_{10}$: HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947).
Tertiary alcohols from $C_8$ to $C_{14}$: QUAYLE and SMART (1944).
DOROUGH, GLASS, GRESHAM, MALONE and REID (1941) have studied a series of methyloctanols (B.P.; d, n, heat of vap.).

## *n*-HEXADECYLALCOHOL or CETYL ALCOHOL $n$-$C_{16}H_{33}OH$

Prepared by WÜRTZ's reaction using pure cetyl iodide.

It is then purified by fractional crystallization, first in glacial acetic acid to eliminate the iodide, then in carbon tetrachloride. The constancy of the melting point for successive fractions is the best criterion of purity.

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 49°10 | DELCOURT (1931) | 49°22—49°27 | CAREY and SMITH (1933) |
| 49°10 | FISCHER (1939) | 49°27 | SMITH (1931) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² |
|---|---|
| 49.10 | 1 |
| 52.00 | 126 |
| 55.00 | 254 |
| 60.00 | 470 |
| 65.00 | 691 |
| 70.00 | 925 |
| 72.00 | 1014 |

*Transition curve:* DEFFET (1935)

| t° | p kg/cm² |
|---|---|
| 44.05 | 1 |
| 45.00 | 48.5 |
| 48.10 | 214 |
| 52.00 | 430 |
| 55.00 | 585 |
| 60.00 | 847 |
| 61.50 | 932 |

*Density*

| t° | d | |
|---|---|---|
| 55 | 0.81521 | DELCOURT (1931) |
| 75 | 0.80157 | „ |
| 100 | 0.78395 | „ |
| 79.7 | 0.7984 | EYKMAN (1893) |

*Viscosity*

| t° | $\eta \cdot 10^3$ | |
|---|---|---|
| 50 | 134 | DELCOURT (1931) |
| 60 | 84.2 | „ |
| 75 | 53.8 | „ |

*Refractive index:* 79°7 Hα 1.42614 Hβ 1.43353 EYKMAN (1893)

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_v$) 10302.7 cal 15°/g<br>25° ($c_v$) 10302.7 „ | BECKERS (1931)<br>RICHARDSON and PARKS (1939) |

## ALLYL ALCOHOL $CH_2{=}CH.CH_2OH$

This product is dried by fractional distillation over lime. The criterion of purity is the constancy of the density or of the critical solution point in paraffin oil. Water can also be eliminated as a constant boiling mixture (88°2), or as a ternary azeotrope with benzene. (ATKINS and WALLACE, 1912–13).

**Constants:** B.E. (1932)

*Saturated vapour pressure:* EWERT (1936)

| t° | p mm | t° | p mm |
|---|---|---|---|
| 21.0 | 22.8 | 35.0 | 47.1 |
| 25.0 | 28.1 | 40.0 | 61.2 |
| 30.0 | 36.3 | | |

*Boiling point*

| | | |
|---|---|---|
| 96°85 | $\frac{dt}{dp}$ *(10 mm):* 0°38 | LECAT (passim) |
| 97°0 | „ 0°40 | B.E. (1932) |
| 97°06 | | WALLACE and ATKINS (1912) and ATKINS and WALLACE (1913) |
| 97°08 | | EWERT (1936) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.86814 | B.E. (1932) | 30 | 0.84209 | B.E. (1932) |
| 15 | 0.85511 | „ | 0 | 0.86795 | Ewert (1936) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1486 | B.E. (1932) |
| 30 | 1072 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 26.15 | B.E. (1932) |
| 20 | 25.68 | „ |
| 30 | 24.92 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.41118 | 1.41175 | 1.41452 | 1.41982 | 1.42141 | 1.42545 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00041 | 41 | 41 | 40 | 42 | 45 | „ |
| 20 | 1.40911 | — | 1.41246 | 1.41778 | — | 1.42322 | Ewert (1936) |

Kenyon and Snellgrove (1925) have studied the following alcohols; their values seem to be reliable, but there are no data for comparison.

| | |
|---|---|
| *d*-Methylvinyl carbinol | $CH_3—CHOH—CH=CH_2$ |
| *l*-Ethylvinyl „ | $C_2H_5—CHOH—CH=CH_2$ |
| *n*-Propylvinyl „ | $C_3H_7—CHOH—CH=CH_2$ |
| *n*-Butylvinyl „ | $C_4H_9—CHOH—CH=CH_2$ |

## THE POLYALCOHOLS

Van Voorst (1928) studied a series of glycols (density and refractive indices) from ethylene glycol up to tetradecyl glycol. This work appears to have been done well, but, for ethylene glycol, there are discrepancies with the values given by other authors.

### ETHYLENE GLYCOL $(CH_2OH)_2$

**Constants:** B.E. (1935)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 186.5 | 544.3 | de Forcrand (1901) | 117 | 29 | Boeseken and Heilmann (1923) |
| 173.2 | 357.3 | „ | | | |
| 140.8 | 101 | „ | 101 | 12 | Kailan and Melkus (1927) |
| 136.7 | 83 | „ | | | |
| 122.5 | 44 | „ | | | |

| *Boiling point* | | | *Freezing point* | |
|---|---|---|---|---|
| 197°4 | $\frac{dt}{dp}$ *(10 mm):* | 0°50 LECAT (passim) | −12°6 | B.E. (1935) |
| 197°85 | „ | 0°50 B.E. (1935) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.12763 | B.E. (1935) | 0 | 1.12760 | EWERT (1937) |
| 15 | 1.11710 | „ | 15 | 1.1170 | MOUREU and DODE (1937) |
| 30 | 1.10664 | „ | 17.8 | 1.1149 | EYKMAN (1919) |
| 0 | 1.1274 | WALDEN (1906) | 25 | 1.11005 | KAILAN and MELKUS (1927) |
| 25 | 1.1099 | „ | 25 | 1.10986 | GIBSON and KINCAID (1937) |
| | | | 25 | 1.10987 | GIBSON and LOEFFLER (1941) |

*Viscosity*

| t° | $\eta \cdot 10^4$ | |
|---|---|---|
| 15 | 2609 | B.E. (1935) |
| 30 | 1335 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.43056 | 1.43092 | 1.43312 | 1.43328 | 1.43732 | 1.43831 | 1.44146 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00026 | 26 | — | 26 | 27 | 27 | 27 | „ |
| 16 | — | — | 1.4329 | — | — | — | — | MOUREU and DODE (1937) |
| 15 | 1.43058 | — | — | 1.43320 | 1.43730 | — | 1.44141 | EWERT (1937) |
| 25 | — | — | 1.43063 | — | — | — | — | WALDEN (1907) |

| *Heat of combustion* | 25°, ($c_v$) 4578.2 cal 15°/g | PARKS, WEST, NAYLOR, FUJII and MCCLAINE (1946) (M.W. 62.068) |
|---|---|---|

## GLYCEROL $CH_2OH.CHOH.CH_2OH$

Impure glycerol contains metallic salts and must be distilled in a good vacuum to avoid decomposition; after this treatment, it can easily be dehydrated and purified by fractional distillation under ordinary pressure.

Glycerol is now commercially available in a fairly pure state.

The criteria of purity are the constancy of the density and of the critical solution point in *iso*amyl alcohol.

**Constants:** B.E. (1935). — **Polyphasic equilibria**

*Saturated vapour pressure:* RICHARDSON (1886)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 139.04 | 2.338 | 183.25 | 20.461 | 220.3 | 100.813 |
| 141.04 | 2.588 | 183.40 | 20.512 | 224.3 | 115.25 |
| 143.645 | 3.046 | 192.0 | 30.62 | 227.0 | 130.535 |
| 145.555 | 3.285 | 193.30 | 34.369 | 229.5 | 137.95 |
| 147.06 | 3.385 | 199.8 | 41.81 | 237.1 | 183.503 |
| 151.99 | 4.083 | 200.8 | 44.865 | 241.80 | 201.225 |
| 162.45 | 8.115 | 201.3 | 45.61 | 246.4 | 239.95 |
| 169.70 | 12.059 | 205.8 | 52.767 | 248.5 | 258.627 |
| 171.05 | 12.694 | 211.5 | 65.61 | 257.3 | 347.092 |
| 175.52 | 15.683 | 217.3 | 86.725 | 260.4 | 385.326 |

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 290°0 | LEWIS (1922) | 17°9 | GIBSON and GIAUQUE (1923) |
| 290°5 | LECAT (passim) | 18°18 | ALBRIGHT (1937) |
| 290°6 | MAC EWEN (1923) | 18°2 | LOUGUININE (1880) |
| | | 18°6 | VOLMER and MARDER (1931) |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 1.26443 | B.E. (1935) | 15 | 1.2644 | SCHOORL (1922) |
| 20 | 1.26134 | „ | 20 | 1.2613 | „ |
| 30 | 1.25512 | „ | | | |
| | | | 13.2 | 1.2651 | PATTERSON (1901) |
| 20 | 1.2613 | WINTHER (1907) | 30 | 1.2552 | „ |
| 30 | 1.2552 | „ | 54.0 | 1.2397 | „ |
| 40 | 1.2490 | „ | 75.5 | 1.2256 | „ |
| 50 | 1.2423 | „ | 99.5 | 1.2097 | „ |
| 60 | 1.2359 | „ | 15 | 1.26415 | BOSART (1939) (priv. comm.) |
| 15 | 1.2641 | DOULIZKAYA (1945) | 20 | 1.2613 | ALBRIGHT (1937) |

*Viscosity*

| t° | $\eta$ | |
|---|---|---|
| 15 | 22.67 | B.E. (1935) |
| 30 | 5.87 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He v. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.47275 | 1.47319 | 1.47547 | 1.47563 | 1.48009 | 1.48126 | 1.48450 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00022 | 22 | — | 22 | 22 | 23 | 23 | „ |

**Heat constants**

OBLAD and NEWTON (1937) give the heat content of anhydrous glycerol between −106°26 and +19°44.

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −203.26 | 0.1087 | −180.56 | 0.1374 | − 89.66 | 0.2290 | GIBSON and GIAUQUE |
| −202.86 | 0.1091 | −179.26 | 0.1399 | −79.46 | 0.2390 | „ (1923) |
| −201.86 | 0.1106 | −175.06 | 0.1453 | −57.56 | 0.2599 | „ |
| −197.06 | 0.1159 | −168.46 | 0.1524 | −55.06 | 0.2618 | „ |
| −192.46 | 0.1223 | −157.46 | 0.1632 | −46.46 | 0.2622 | „ |
| −191.76 | 0.1234 | −145.36 | 0.1742 | −27.86 | 0.2922 | „ |
| −190.06 | 0.1249 | −135.06 | 0.1846 | −23.86 | 0.2944 | „ |
| −187.36 | 0.1289 | −124.46 | 0.1945 | −13.46 | 0.3095 | „ |
| −187.16 | 0.1291 | −111.36 | 0.2081 | − 3.26 | 0.3232 | „ |
| −184.46 | 0.1321 | − 99.56 | 0.2193 | | | „ |
| C. −270.08 | 0.000055 | −258.58 | 0.00683 | −218.59 | 0.0784 | AHLBERG, BLANCHARD |
| −269.30 | 0.00010 | −255.71 | 0.0107 | −212.16 | 0.0883 | and LUNDBERG (1937) |
| −268.13 | 0.000209 | −253.62 | 0.0139 | −206.35 | 0.0991 | „ |
| −266.86 | 0.000450 | −251.27 | 0.0176 | −200.82 | 0.1071 | „ |
| −265.72 | 0.00076 | −247.91 | 0.0238 | −195.71 | 0.1153 | „ |
| −264.65 | 0.00126 | −243.61 | 0.0313 | −190.83 | 0.1218 | „ |
| −263.50 | 0.00187 | −237.80 | 0.0415 | −186.24 | 0.1292 | „ |
| −262.18 | 0.00288 | −230.20 | 0.0561 | | | „ |
| −260.69 | 0.00449 | −223.97 | 0.0686 | | | „ |

| | | |
|---|---|---|
| *Heat of melting* | 17°9 47.50 cal 15°/g | GIBSON and GIAUQUE (1923) |
| | 47.95 „ | VOLMER and MARDER (1931) |

## ERYTHRITOL $CH_2OH.(CHOH)_2.CH_2OH$

### Constants

*Melting point:* 118°9 Parks and Anderson (1926)

*Specific heat:* Parks and Anderson (1926)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −186.1 | 0.110 | −173.5 | 0.124 | − 87.1 | 0.212 | 2.3 | 0.300 |
| −180.8 | 0.116 | −171.9 | 0.127 | − 79.6 | 0.219 | 15.9 | 0.315 |
| −178.4 | 0.119 | −167.5 | 0.131 | − 72.6 | 0.227 | 18.6 | 0.317 |
| −174.1 | 0.124 | −161.4 | 0.137 | + 2.2 | 0.300 | | |

| | | |
|---|---|---|
| *Heat of combustion* | 25°, ($c_v$) 4096.0 cal 15°/g | Parks, West, Naylor, Fujii and Mc Claine (1946) (M.W. 122.120) |

## MANNITOL $CH_2OH.(CHOH)_4.CH_2OH$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 165°98 | Burriel-Marti (1930) | 166° | Pearce and Snow (1927) |
| 166° | Krafft and Dijes (1895) | 166°0 | Parks and Anderson (1926) |

*Specific heat:* Parks and Anderson (1926)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −184.6 | 0.107 | −165.8 | 0.127 | −120.1 | 0.171 | −71.5 | 0.218 |
| −178.7 | 0.113 | −164.9 | 0.128 | −112.8 | 0.178 | + 1.9 | 0.290 |
| −177.2 | 0.115 | −162.0 | 0.131 | − 79.9 | 0.209 | 16.9 | 0.307 |
| −171.1 | 0.121 | −154.8 | 0.137 | − 75.1 | 0.214 | 21.0 | 0.310 |

| | | |
|---|---|---|
| *Heat of combustion* | 25°, ($c_v$) 3969.5 cal 15°/g | Parks, West, Naylor, Fujii and Mc Claine (1946) (M.W. 182.172) |

## B. ETHERS and ACETALS

### DIMETHYL ETHER $(CH_3)_2O$

This gas is prepared by heating a mixture of methanol and concentrated sulphuric acid. At 80°—85° dimethylether is evolved and is separated from carbon dioxide and moisture by passing over caustic potash, lime and phosphorus pentoxide. It is then fractionated at low temperature (LEDUC's method, 1898)

**Constants. — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 126°90 | 52.0 | — | CARDOSO and BRUNO (1923) |
| 127°1 | 53.0 | — | BRINER and CARDOSO (1908), BRINER (1907), GUYE and BRINER (1909) |
| — | — | 0.2714 | CARDOSO and COPPOLA (1923) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|
| 126.50 | 0.3098 | 0.2337 | 110.50 | 0.4550 | 0.1076 | CARDOSO and COPPOLA |
| 126.01 | 0.3293 | 0.2139 | 96.52 | 0.5042 | 0.0754 | „ (1923) |
| 125.01 | 0.3518 | 0.1932 | 80.15 | 0.5522 | 0.0486 | „ |
| 124.19 | 0.3646 | 0.1812 | 56.05 | 0.6012 | 0.0290 | „ |
| 121.12 | 0.3950 | 0.1548 | 29.85 | 0.6458 | 0.0160 | „ |
| 115.90 | 0.4308 | 0.1258 | 0.20 | 0.6903 | 0.0042 | „ |

*Saturated vapour pressure:* KENNEDY, SAGENKAHN and ASTON (1941)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| −101.53 | 4.97 | −78.23 | 35.13 | −55.15 | 164.34 | −35.11 | 475.55 |
| − 95.45 | 8.46 | −70.67 | 60.91 | −49.91 | 221.71 | −31.19 | 571.59 |
| − 94.95 | 8.82 | −65.26 | 87.80 | −45.11 | 287.53 | −27.68 | 670.27 |
| − 89.75 | 13.80 | −60.04 | 122.37 | −40.03 | 373.61 | −24.92 | 756.42 |

CARDOSO and BRUNO (1923)

| t° | p atm. | t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|---|---|
| 126.90 | 52.00 | 112.80 | 40.43 | 64.68 | 15.95 | 25.40 | 6.05 |
| 125.90 | 51.00 | 110.57 | 38.82 | 56.02 | 13.11 | 23.75 | 5.64 |
| 122.20 | 47.67 | 99.90 | 32.14 | 49.75 | 11.22 | 16.80 | 4.58 |
| 117.80 | 44.06 | 99.20 | 31.75 | 48.50 | 10.91 | 9.25 | 3.58 |
| 116.82 | 43.41 | 90.25 | 26.80 | 46.13 | 10.31 | 0.00 | 2.52 |
| 113.75 | 41.24 | 80.10 | 22.14 | 33.55 | 7.49 | | |

*Boiling point*

| | |
|---|---|
| −24·82 | Kennedy, Sagenkahn and Aston (1941) |
| −24°9 | Maass and Boomer (1922) |
| −24°9 | Grosse (1937) |

*Melting point*

| | |
|---|---|
| −141·50 | Kennedy, Sagenkahn and Aston (1941) |

**Constants of state**

*Weight of the gas:* (normal litre) 2.1097 Batuecas (1924)
(at 25° and 1 atm.) 1.91855 ± 0.00012 Kennedy, Sagenkahn and Aston (1941)

*Coefficient of dilatation of the gas:* (11°03 → 48°01) $3920 \cdot 10^{-6}$ 760 mm Coppok and Whytlaw—Gray (1934)

*Deviation from Avogadro's law:* $A_0^I$: − 1.0270 Batuecas (1924)

*Viscosity:* Van Cleave and Maass (1935)

| t° | $\eta \cdot 10^7$ | t° | $\eta \cdot 10^7$ | t° | $\eta \cdot 10^7$ | t° | $\eta \cdot 10^7$ |
|---|---|---|---|---|---|---|---|
| −56.91 | 658.4 | −23.39 | 755.2 | −0.13 | 824.7 | 18.11 | 883.0 |
| −41.16 | 703.0 | − 8.67 | 797.4 | 11.71 | 862.4 | 22.90 | 899.4 |

**Heat constants**

*Specific heat:* Kennedy, Sagenkahn and Aston (1941) (M.W. 46.069)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −259.46 | 0.0169 | −216.68 | 0.1852 | −151.04 | 0.3386 | −86.98 | 0.5141 |
| −257.17 | 0.02528 | −213.16 | 0.1946 | −145.41 | 0.3500 | −82.29 | 0.5145 |
| −254.47 | 0.03722 | −211.29 | 0.2014 | −143.85 | 0.3777 | −76.86 | 0.5151 |
| −252.01 | 0.04901 | −199.02 | 0.2342 | −135.98 | 0.5091 | −72.53 | 0.5161 |
| −248.89 | 0.06304 | −193.48 | 0.2482 | −130.46 | 0.5097 | −67.57 | 0.5173 |
| −244.96 | 0.07990 | −187.82 | 0.2607 | −124.59 | 0.5099 | −62.65 | 0.5184 |
| −240.80 | 0.09909 | −181.87 | 0.2740 | −124.41 | 0.5101 | −55.20 | 0.5195 |
| −236.98 | 0.1151 | −176.23 | 0.2861 | −110.24 | 0.5104 | −49.87 | 0.5212 |
| −233.67 | 0.1287 | −170.46 | 0.2993 | −108.24 | 0.5108 | −44.43 | 0.5236 |
| −230.14 | 0.1410 | −164.45 | 0.3124 | −100.21 | 0.5114 | −38.83 | 0.5243 |
| −225.18 | 0.1588 | −156.71 | 0.3280 | − 94.19 | 0.5125 | −27.68 | 0.5351 |
| −219.28 | 0.1771 | | | | | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | −24·80 111.64 cal 15°/g | Kennedy, Sagenkahn and Aston (1941) |
| *Heat of melting* | 25.621 „ | „ |

## DIETHYL ETHER $(C_2H_5)_2O$

Strange though it may seem, the constants of ether are not yet accurately known, despite the great number of studies that have been made of it.

A general survey of the old research material (up to 1903) concerning the properties of ether, notably the density, may be found in one of Bein's memoirs (1908).

The works of Wade and Finnemore (1909) and Clarke (1924) are generally considered as careful. The works of Rowe (1924) and Rowe and Phelps (1924) concerning the impurities of ether for anesthesia and the work of Perkins (1917) are also interesting; a general survey of the constants of pure ether has been published by Baskerville and Hamor (1911). The research concerning the impurities in ether by Middleton and Hymas (1931) may also be mentioned.

In order to obtain ether having invariable properties, ordinary ether is first distilled to get rid of the head fraction; it is then directly distilled over sulphuric acid and allowed to stand over sodium or $P_2O_5$ for a prolonged period.

Finally it is fractionated in the absence of moisture. The chemical treatment is necessary because ether forms an azeotrope with 1,3 % water distilling at 34°15; it cannot be separated by mere distillation: neither can ethyl alcohol be removed by physical means, although it does not give an azeotrope with ether (Wade and Finnemore). The ethyl alcohol is also retained by $P_2O_5$. Attaining the fifth degree of purity ($\Delta t = 0°000$) with the ebulliometer of Swietoslawski offers no difficulty. Pure ether must be kept in vacuo, in sealed tubes and in the dark.

A general experimental and critical work, concerning the principal constants of ether, was published by B.E. (1928); a study of the impurities, their quantitative determination and the purification of ether, by Gillo (1938); the quantitative determination of water in ether, by Gaspart and Serrure (1939). According to Gillo, small amounts of ether peroxide ($10^{-4}$ %) can be detected by iodometry; and of aldehyde, by decolorised fuchsin. Gillo eliminated traces of aldehydes, alcohols and unsaturated compounds by permanganate oxidation; acids were neutralized and the ether then submitted to the previously described treatment.

**Constants:** B.E. (1928). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 193°6 | — | — | De Vries (1895) |
| 193°61 | 27565 | 0.2665 | Wilip (1924) |
| 193°62 | — | — | Travers and Usher (1906) |
| 193°8 | 27060 | 0.2625 | Young (1910) |
| 193°9 | 27436 | — | Scheffer (1913) and Prins (1915) |

Influence of small quantities of water: Paul and Schantz (1919)

*Densities of the liquid and the saturated vapour:* YOUNG (1910)

| t° | L. | V. | t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.7362 | 0.000827 | 80 | 0.6402 | 0.01155 | 160 | 0.4947 | 0.06911 |
| 10 | 0.7248 | 0.001264 | 90 | 0.6250 | 0.01477 | 170 | 0.4658 | 0.08731 |
| 20 | 0.7135 | 0.001870 | 100 | 0.6105 | 0.01867 | 180 | 0.4268 | 0.1135 |
| 30 | 0.7019 | 0.002677 | 110 | 0.5942 | 0.02349 | 185 | 0.4018 | 0.1320 |
| 40 | 0.6894 | 0.003731 | 120 | 0.5764 | 0.02934 | 190 | 0.3663 | 0.1620 |
| 50 | 0.6764 | 0.005079 | 130 | 0.5580 | 0.03638 | 192 | 0.3448 | 0.1826 |
| 60 | 0.6658 | 0.006771 | 140 | 0.5385 | 0.04488 | 193 | 0.3300 | 0.2012 |
| 70 | 0.6532 | 0.00892 | 150 | 0.5179 | 0.05551 | | | |

*Rectilinear diameter:* $0.3685 - 5377 \cdot 10^{-7}\,t° - 475 \cdot 10^{-10}\,t°^2$ YOUNG (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −101.3 | 0.058 | −93.4 | 0.150 | −81.0 | 0.584 | MÜNDEL (1913) |
| − 96.7 | 0.096 | −88.1 | 0.270 | −78.5 | 0.762 | ,, |
| − 95.2 | 0.118 | −83,5 | 0.443 | −76.2 | 0.949 | ,, |
| −60.799 | 3.95 | −31.329 | 34.03 | +0.009 | 186.13 | TAYLOR and SMITH (1922) |
| −55.748 | 5.93 | −26.421 | 45.81 | 4.975 | 233.73 | ,, |
| −50.873 | 8.77 | −21.502 | 61.31 | 9.937 | 290.62 | ,, |
| −45.998 | 12.62 | −16.578 | 80.67 | 14.903 | 358.15 | ,, |
| −41.125 | 17.78 | −11.637 | 104.79 | 19.871 | 437.70 | ,, |
| −36.231 | 24.77 | − 6.698 | 134.76 | | | ,, |
| −10 | 112.3 | 80 | 2974 | 160 | 15778 | YOUNG (1910) |
| 0 | 184.9 | 90 | 3831 | 170 | 18671 | ,, |
| 10 | 290.8 | 100 | 4855 | 180 | 21775 | ,, |
| 20 | 439.8 | 110 | 6082 | 185 | 23623 | ,, |
| 40 | 921.0 | 120 | 7513 | 190 | 25513 | ,, |
| 50 | 1276 | 130 | 9155 | 192 | 26331 | ,, |
| 60 | 1734 | 140 | 11051 | 193 | 26800 | ,, |
| 70 | 2304 | 150 | 13262 | 193.8 | 27060 | ,, |
| 0.0 | 185.3 | 20.0 | 442.2 | 40.0 | 921.8 | LOUDER, BRIGGS and BROWN (1924) |
| 5.0 | 233.2 | 25.0 | 537.0 | 45.0 | 1089.8 | |
| 10.0 | 291.7 | 30.0 | 647.3 | 50.0 | 1276.4 | ,, |
| 15.0 | 360.7 | 35.0 | 775.5 | | | ,, |
| 15.5 | 364.2 | 20.5 | 447.1 | | | JOUKOVSKY (1934) |
| 18.0 | 404.3 | 22.8 | 490.3 | | | ,, |
| 19.3 | 427.1 | 24.3 | 521.8 | | | ,, |
| 20 | 440 | 30 | 646.8 | | | SCHULZE (1921) |
| 156.9 | 15200 | 171.1 | 19228 | 185.3 | 24092 | SCHEFFER (1913) |
| 160.9 | 16302 | 177.3 | 21204 | 190.5 | 25992 | ,, |
| 165.5 | 18240 | 180.8 | 22458 | 193.9 | 27436 | ,, |

*Isotherms:* BEATTIE (1924), JÖNSSON (1887—88) and KEYES and FELSING (1919)

*Boiling point*

| | | | |
|---|---|---|---|
| 34°40 | MARSHALL (1906) | 34°6 | PERKIN (1884) |
| 34°47 | CLARKE (1924) | 34°6 | RICHARDSON (1891) |
| 34°481 | WOJCIECHOWSKI (1936) | 34°60 | TYRER (1914) |
| 34°50 | WADE and FINNEMORE (1909) | 34°60 | B.E. (1928) and LECAT (passim) |
| 34°50 | MÜNDEL (1913) | 34°60 | YOUNG (1910) |
| 34°54 | GRIMM and PATRICK (1923) | 34°600 | LALANDE (1934) |
| 34°58 | MORINO (1933) | | |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°36 | B.E. (1928) and LECAT (passim) | 0°372 | WOJCIECHOWSKY (1936) |

*Melting point*

| *Stable form:* | | *Metastable form:* | |
|---|---|---|---|
| −116°3 | TIMMERMANS, VAN DER HORST and KAMERLINGH ONNES (1922) | −123°3 | TIMMERMANS (1912) |
| | | −123°3 | MAC NEIGHT and SMYTH (1936) |
| −116°3 | PARKS and HUFFMAN (1926) | −123°4 | PARKS and HUFFMAN (1926) |
| −116°3 | MAC NEIGHT and SMYTH (1936) | −123°40 | KEYES, TOWNSHEND and YOUNG (1922) |

## Constants of state

*Density*

The discrepancies shown in the results of several creditable authors indicate once more the difficulty of securing perfectly reliable values for measurements at different temperatures.

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| 15.4 | 0.71886 | −37.2 | 0.77707 | − 94.5 | 0.83679 | TIMMERMANS (1912) |
| 0 | 0.73627 | −45.0 | 0.78540 | −104.85 | 0.84696 | ,, |
| − 6.2 | 0.74285 | −53.6 | 0.79459 | −111.6 | 0.85365 | ,, |
| −13.1 | 0.75092 | −63.3 | 0.80440 | −116.2 | 0.85844 | ,, |
| −22.95 | 0.76132 | −73.95 | 0.81500 | −123.3 | 0.86538 | ,, |
| −30.6 | 0.76994 | −74.25 | 0.81554 | | | ,, |
| −35.3 | 0.77520 | −83.4 | 0.82519 | | | ,, |

*Density* (continued)

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| 70 | 0.65226 | 5 | 0.73069 | — 60 | 0.80084 | Taylor and Smith (1922) |
| 65 | 0.65866 | 0 | 0.73629 | — 65 | 0.80606 | „ |
| 60 | 0.66501 | — 5 | 0.74180 | — 70 | 0.81126 | „ |
| 55 | 0.67129 | —10 | 0.74729 | — 75 | 0.81643 | „ |
| 50 | 0.67751 | —15 | 0.75275 | — 80 | 0.82159 | „ |
| 45 | 0.68367 | —20 | 0.75819 | — 85 | 0.82672 | „ |
| 40 | 0.68976 | —25 | 0.76360 | — 90 | 0.83182 | „ |
| 35 | 0.69580 | —30 | 0.76899 | — 95 | 0.83690 | „ |
| 30 | 0.70177 | —35 | 0.77436 | —100 | 0.84196 | „ |
| 25 | 0.70768 | —40 | 0.77970 | —105 | 0.84699 | „ |
| 20 | 0.71352 | —45 | 0.78502 | —110 | 0.85200 | „ |
| 15 | 0.71930 | —50 | 0.79032 | —115 | 0.85699 | „ |
| 10 | 0.72503 | —55 | 0.79559 | —120 | 0.86195 | „ |

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.73622 | B.E (1928) | 0 | 0.7362 | Young (1910) |
| 15 | 0.71925 | „ | 10 | 0.7248 | „ |
| 30 | 0.70205 | „ | 20 | 0.7135 | „ |
| | | | 30 | 0.7019 | „ |
| | | | 40 | 0.6894 | „ |
| 15 | 0.71930 | Wade and Finnemore (1909) | 20 | 0.7135 | Schulze (1912) |
| 20 | 0.7134 | Stearn and Smith (1934) | 20 | 0.7135 | Deutschmann (1911) |
| 20 | 0.7135 | Lowry (1914) | 25 | 0.70778 | Lalande (1934) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0 | 279 | B.E. (1928) | 0 | 288 | Sachanov and Rjachovsky |
| 15 | 247 | „ | 25 | 224 | „ (1914) |
| | | | 20 | 234.5 | Dolezalek and Schulze (1913) |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 17.62 | Hennaut-Roland and Lek | 20 | 17.04 | Desreux (1935) |
| 20 | 17.06 | „ (1931) | 20 | 17.01 | (vacuum) Richards and Carver (1921) |
| 30 | 15.95 | „ | 20 | 16.96 | (no vacuum) Richards and Carver (1921) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.35341 | 1.35381 | 1.35555 | 1.35557 | 1.35910 | 1.36005 | 1.36263 | 1.36375 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00055 | 56 | 56 | 56 | 56 | 56 | 56 | 58 | „ |
| 12.6 | — | — | — | 1.35691 | — | — | — | — | Joukovsky (1934) |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| −40 | 5.910 | Le Fevre (1938) | 0 | 4.803 | Le Fevre (1938) |
| −30 | 5.600 | „ | 10 | 4.575 | „ |
| −20 | 5.325 | „ | 20 | 4.376 | „ |
| −10 | 5.066 | „ | 25 | 4.265 | „ |
| | | | 30 | 4.152 | „ |

*Specific magnetic susceptibility:* 20° −0.60 Henrichsen (1888)

*Molecular magnetic rotatory power:* 20° 4.777 Perkin (1884)

20° 4.84 Lowry (1914)

**Heat constants**

*Specific heat:* Parks and Huffman (1926)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| C. −197.06 | 0.201 | −175.86 | 0.236 | −158.66 | 0.259 |
| −190.66 | 0.212 | −169.46 | 0.244 | −149.86 | 0.271 |
| −184.06 | 0.222 | −162.66 | 0.254 | −142.06 | 0.283 |
| −179.76 | 0.227 | −162.36 | 0.255 | −137.96 | 0.287 |
| −176.46 | 0.233 | −161.16 | 0.256 | | |
| L. −108.76 | 0.475 | −67.66 | 0.505 | 7.04 | 0.547 |
| − 87.06 | 0.490 | −59.66 | 0.507 | 12.84 | 0.549 |
| − 77.56 | 0.498 | + 2.04 | 0.544 | 16.84 | 0.551 |
| − 71.56 | 0.501 | | | | |

*Heat of vaporisation* cal 15°/g

| | | |
|---|---|---|
| 10° | 92.37 | Leduc (1917) |
| 30° | 89.80 | „ |
| 50° | 86.93 | „ |

## DI-*n*-PROPYL ETHER $(n\text{-}C_3H_7)_2O$

**Constants:** B.E. (1930)

*Saturated vapour pressure:* BINGHAM (1910)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 8.80 | 29.9 | 33.01 | 95.4 | 66.30 | 356.2 | 81.80 | 598.0 |
| 11.95 | 34.2 | 41.60 | 134.1 | 70.01 | 404.1 | 83.19 | 625.0 |
| 18.40 | 47.3 | 45.23 | 155.0 | 71.99 | 432.6 | 84.75 | 654.6 |
| 21.42 | 55.4 | 49.52 | 184.9 | 73.60 | 456.6 | 86.10 | 682.4 |
| 24.05 | 62.1 | 57.50 | 255.1 | 77.40 | 517.6 | 86.89 | 701.4 |
| 27.61 | 73.7 | 59.70 | 278.4 | 79.00 | 546.9 | 88.78 | 741.1 |
| 28.71 | 76.9 | 62.47 | 309.8 | 80.40 | 572.1 | | |

*Boiling point*

| | |
|---|---|
| 90°05 | WUYTS and LACOURT (1930) |
| 90°1 | $\frac{dt}{dp}$ *(10 mm):* 0°47 (1930) and LECAT (passim) |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.76611 | B.E. (1930) |
| 15 | 0.75178 | „ |
| 30 | 0.73737 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 21.12 | B.E. (1930) |
| 20 | 20.53 | „ |
| 30 | 19.35 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.59 | 535.9 | THORPE and RODGER | 56.15 | 287.7 | THORPE and RODGER |
| 8.58 | 482.6 | „ | 64.16 | 266.4 | „ (1897) |
| 16.95 | 435.8 | „ (1897) | 72.59 | 246.9 | „ |
| 24.65 | 398.5 | „ | 81.47 | 228.4 | „ |
| 32.46 | 365.5 | „ | 88.02 | 215.4 | „ |
| 40.47 | 336.0 | „ | 15 | 448 | B.E. (1930) |
| 48.06 | 311.4 | „ | 30 | 376 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.38049 | 1.38090 | 1.38296 | 1.38673 | 1.38759 | 1.39062 | 1.39169 |
| $\frac{dn}{dt}$ | 0.00049 | 49 | 49 | 50 | 50 | 53 | 51 |

## DI-*iso*-PROPYL ETHER $[(CH_3)_2CH]_2O$

*Saturated vapour pressure, boiling point, density, viscosity, surface tension, refractive index* and *heat of vaporisation:* FIFE and REID (1930). *Boiling point, density, refractive index:* SNYDER and GILBERT (1942). *Boiling point:* LECAT (passim); *freezing point:* TIMMERMANS (passim) and PARKS (1925). The values of FIFE and REID (1930) and of SNYDER and GILBERT (1942) do not agree.

## DI-*n*-BUTYL ETHER $(n\text{-}C_4H_9)_2O$

**Constants:** B.E. (1930)

*Saturated vapour pressure:* HILL and FITZGERALD (1935)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 11.3 | 7.5 | 19.7 | 10.5 | 25.9 | 12.7 |
| 15.4 | 9.0 | 25.0 | 12.5 | 29.7 | 14.5 |

*Boiling point*

| | | |
|---|---|---|
| 142°4 | $\frac{dt}{dp}$ *(10 mm):* | 0°50 LECAT (passim) |
| 142°4 | | POPELIER (1923) |
| 142°40 | | 0°50 B.E. (1930) |

*Freezing point*: −97°9 TIMMERMANS (passim)

*Density*

| t° | d |
|---|---|
| 0 | 0.78536 |
| 15 | 0.77254 |
| 30 | 0.75976 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 741 |
| 30 | 602 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 23.40 |
| 20 | 22.93 |
| 30 | 21.99 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ |
|---|---|---|---|---|---|
| 15 | 1.39665 | 1.39698 | 1.39906 | 1.40297 | 1.40393 |
| $\frac{dn}{dt}$ | 0.00043 | 45 | 45 | 45 | 45 |

## DI-*n*-AMYL ETHER $(n\text{-}C_5H_{11})_2O$

This compound can only be obtained in a pure state from synthetic *n*-amyl alcohol.

**Constants:** B.E. (1928)

*Boiling point:* 187°50 $\frac{dt}{dp}$ *(10 mm):* 0°57 B.E. (1928) and LECAT (passim)

*Freezing point:* −69°3

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.79881 | B.E. (1928) |
| 15 | 0.78695 | „ |
| 30 | 0.77505 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1188 | B.E. (1928) |
| 30 | 922 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 25.25 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 24.76 | „ |
| 30 | 23.78 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.41159 | 1.41167 | 1.41392 | 1.41423 | 1.41834 | 1.41902 | 1.42313 |
| $\frac{dn}{dt}$ | 0.00042 | 42 | 42 | 42 | 42 | 42 | 42 |

## METHYL-ETHYL ETHER $CH_3.O.C_2H_5$

Mixed ethers are prepared by the action of the alkyl iodide on the sodium alcoholate in alcoholic solution.

**Constants:** BERTHOUD and BRUM (1924)

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 164°7 | 0.2722 | |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.7260 | 0.0024 | 138.4 | 0.4927 | 0.0791 |
| 78.3 | 0.6142 | 0.0233 | 145.2 | 0.4690 | 0.0953 |
| 94.5 | 0.5883 | 0.0311 | 150.2 | 0.4488 | 0.1116 |
| 119.3 | 0.5406 | 0.0521 | 154.5 | 0.4306 | 0.1251 |
| 130.0 | 0.5160 | 0.0654 | 158.2 | 0.4136 | 0.1406 |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 0 | 560 | 50 | 3192 | 90 | 8740 | 130 | 19000 |
| 10 | 841 | 60 | 4256 | 100 | 10792 | 140 | 22496 |
| 20 | 1222 | 70 | 5472 | 110 | 13148 | 150 | 26524 |
| 30 | 1732 | 80 | 6992 | 120 | 15960 | 160 | 30856 |
| 40 | 2385 | | | | | | |

*Boiling point:* 7°6

*Density* *Surface tension*

| t° | d | t° | d | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 0 | 0.7260 | 32.3 | 0.6825 | 7.9 | 17.54 | Berthoud and Brum (1924) |
| 13.6 | 0.7062 | 41.9 | 0.6701 | 33.5 | 14.10 | ,, |
| 21.1 | 0.6973 | 50.7 | 0.6570 | 45.5 | 12.60 | ,, |

## METHYL-*n*-PROPYL ETHER $CH_3.O.n\text{-}C_3H_7$

### Constants

*Saturated vapour pressure:* Bingham (1910)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| −0.60 | 151.8 | 18.67 | 352.6 | 28.25 | 517.6 | 33.80 | 633.9 |
| +3.42 | 180.0 | 20.02 | 376.0 | 29.00 | 533.4 | 34.84 | 658.1 |
| 7.01 | 212.6 | 21.01 | 388.3 | 30.12 | 555.9 | 35.58 | 675.2 |
| 8.81 | 230.9 | 23.00 | 420.5 | 31.01 | 574.5 | 36.73 | 703.8 |
| 12.58 | 272.2 | 23.91 | 436.0 | 31.87 | 594.0 | 38.34 | 739.5 |
| 14.30 | 293.3 | 24.85 | 453.3 | 32.72 | 612.5 | 39.34 | 765.6 |
| 17.60 | 336.9 | 26.80 | 487.5 | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 38°9 | Dobriner (1888) | 39°14 | Bingham (1910) |
| 38·95 | Lecat (passim) | 39·15 | Thorpe and Rodger (1897) |

*Density*

| | | |
|---|---|---|
| 0° | 0.7470 | Dobriner (1888) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.30 | 306.4 | Thorpe and Rodger | 20.10 | 251.3 | Thorpe and Rodger |
| 5.14 | 291.4 | „ (1897) | 25.73 | 238.5 | „ (1897) |
| 10.47 | 275.4 | „ | 29.48 | 230.0 | „ |
| 15.17 | 263.0 | „ | 35.15 | 218.7 | „ |

## ETHYL-*n*-PROPYL ETHER $C_2H_5.O.n\text{-}C_3H_7$

*Critical constants, saturated vapour pressure, boiling point, density* and *surface tension:* Berthoud and Brum (1924). *Saturated vapour pressure:* Bingham (1910). *Viscosity;* Thorpe and Rodger (1897). *Freezing point, heat of vaporisation:* Nagornow and Rotinjanz (1911). The values of Bingham (1910) and Berthoud and Brum (1924) do not agree with each other.

Kenyon and Mac Nicol (1923) studied different mixed *sec.* OCTYL ETHERS (from $CH_3$ up to $C_9H_{19}$). There are no comparison data for these compounds.

## DIVINYL ETHER $(CH_2{=}CH)_2\,O$

*Saturated vapour pressure* and *density:* Miles and Menzies (1933).

## DIMETHYLFORMAL or METHYLAL $CH_2(OCH_3)_2$

This substance forms with methanol an azeotrope, which cannot be eliminated by distillation alone: it boils only 0°25 lower than pure methylal. In order to eliminate methyl alcohol, it is thus necessary to distil the methylal repeatedly over metallic sodium, a process involving a considerable loss of material but leading to a pure product.

**Constants:** B.E. (1928)

*Critical temperature:* 215°2 Bourgom (1924)

*Boiling point*

| | |
|---|---|
| 42°3 | Bourgom (1924) |
| 42°3 | Ghysels (1924) |
| 42°30 | $\frac{dt}{dp}$ *(10 mm):* 0.40 B.E. (1928) and Lecat (passim) |

*Freezing point*

| | |
|---|---|
| −105°0 | B.E. (1928) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.88545 | B.E. (1928) | 0 | 0.88546 | Ghysels (1924) |
| 15 | 0.86645 | „ | 15 | 0.86657 | „ |
| 30 | 0.84745 | „ | 18.2 | 0.8621 | Brühl (1897) |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 0 | 402 | B.E. (1928) | 15 | 21.79 | Hennaut-Roland and Lek (1931 |
| 15 | 340 | „ | 20 | 21.12 | „ |
| 30 | 325 | „ | 30 | 19.76 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.35414 | 1.35430 | 1.35626 | 1.35636 | 1.35963 | 1.36014 | 1.36301 | 1.36356 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00048 | 48 | 49 | 49 | 50 | 50 | 52 | 52 | „ |
| 16 | — | 1.35379 | 1.35553 | — | — | 1.35957 | — | 1.36290 | Bourgom (1924) |
| 18.2 | — | 1.35229 | 1.35397 | — | — | 1.35801 | — | 1.36122 | Brühl (1897) |

*Dielectric constant:* 20° 3.485 Piette (1947)

## DIETHYLFORMAL or ETHYLAL $CH_2(OC_2H_5)_2$

**Constants:** B.E. (1930)

*Boiling point:* 87°95 Lecat

88°00 $\frac{dt}{dp}$ *(10 mm):* 0°44

*Freezing point:* −66°5

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|---|---|
| 0 | 0.85021 | 15 | 442 | B.E. (1930) | 15 | 21.71 | Hennaut-Roland and Lek (1931) |
| 15 | 0.83465 | 30 | 344 | „ | 20 | 21.18 | |
| 30 | 0.81896 | | | „ | 30 | 20.13 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.37317 | 1.37358 | 1.37546 | 1.37893 | 1.37984 | 1.38252 | 1.38314 |
| $\frac{dn}{dt}$ | 0.00046 | 47 | 46 | 46 | 47 | 44 | — |

*Dielectric constant:* 20° 2.885 Piette (1947)

## DI-*n*-BUTYL ACETAL $CH_3.CH(O\ n\text{-}C_4H_9)_2$

*Saturated vapour pressure:* Conner, Elving and Steingiser (1948)

## C. ALDEHYDES

The aldehydes are very difficult to purify, as they are easily oxidised and polymerised. Formaldehyde is purified by sublimation and fractional freezing (Trautz and Ufer, 1926).

## ACETALDEHYDE $CH_3.CHO$

This substance is relatively easy to purify by fractional distillation of a sample obtained by depolymerisation of very pure paraldehyde. The equilibria with paraldehyde were studied by Hollmann (1903), De Leeuw (1910–11) and Smits and De Leeuw (1910).

*Critical temperature* and *boiling point:* Hollmann (1903); *saturated vapour pressure, density* and *refractive index:* De Leeuw (1910–1911), Smits and De Leeuw (1910); *melting point:* Schwab and Wickers (1944); *density:* Perkin (1887); *density* and *viscosity:* Friend and Hargreaves (1944); *density, specific heat* and *heat of vaporisation:* Coleman and De Vries (1949)

## OENANTHAL or *n*-HEPTYL ALDEHYDE $n$-$C_6H_{13}$.CHO

**Constants:** DEFFET (1931)

*Boiling point:* 152°8 $\frac{dt}{dp}$ *(10 mm):* 0°51

*Freezing point:* −43°3 TIMMERMANS

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.83423 | DEFFET (1931) |
| 15 | 0.82162 | „ |
| 30 | 0.80902 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 977 | DEFFET (1931) |
| 30 | 791 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 27.04 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 26.58 | „ |
| 30 | 25.68 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.41247 | 1.41282 | 1.41511 | 1.41952 | 1.42044 | 1.42378 | 1.42471 |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 54 | 54 | 54 | 54 | 54 |

## ACROLEIN or ACRYLIC ALDEHYDE $CH_2$=CH.CHO

*Saturated vapour pressure, boiling point, density* and *refractive index*: MOUREU, BOUTARIC and DUFRAISSE (1920–21).

# D. KETONES

## ACETONE $CH_3$.CO.$CH_3$

The purification of acetone involves two distinct processes. The bisulphite compound is used in order to eliminate the impurities other than ketones; the compound with sodium iodide (SHIPSEY and WERNER, 1913) may also be employed. The product has then to be dehydrated chemically, although no azetrope

is formed with water; small amounts of water do not affect the vapour tension of acetone to an appreciable extent, so that dehydration is impossible even with a powerful dephlegmator.

As dehydrating agent, calcium chloride is ineffective and it is necessary to redistil over a small amount of $P_2O_5$; this process involves a great loss of material through condensation reactions (Timmermans, 1910–1912). According to Gillo (1938), it is possible to obtain a sample containing less than 0.0002 % of water by treating repeatedly with $P_2O_5$ and leading the vapour over this dehydrating agent.

Tests for impurities. (Gillo, 1938): small amounts of methyl alcohol (ebulliometry), of acetaldehyde (decolorised fuchsin), and acetic acid (titrimetry) are determined from $1 \rightarrow 5 \cdot 10^{-4}$ %. The presence of $2 \cdot 10^{-4}$ % of water may be indicated by infra-red spectrography (Gaspart and Gillo, 1938).

Anhydrous acetone must be kept in sealed tubes.

**Constants**: B.E. (1928). — **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 0.32 | 71.4 | Roland (1928) | 0 | 69.2 | Schmidt (1926) |
| 0.92 | 73.9 | „ | 20 | 181.0 | „ |
| 9.98 | 115.9 | „ | 30 | 282.5 | „ |
| 15.00 | 147.1 | „ | 35 | 347.5 | „ |
| 20.14 | 185.7 | „ | 40 | 420.5 | „ |
| 25 | 229.4 | „ | 50 | 619 | „ |
| 29.95 | 281.8 | „ | | | |
| 35.106 | 355.1 | Zmaczynski (1930) | 66.623 | 1074.6 | Zmaczynski (1930) |
| 40.616 | 433.9 | „ | 71.915 | 1268.1 | „ |
| 45.758 | 525.76 | „ | 77.235 | 1489.2 | „ |
| 50.930 | 633.90 | „ | 82.586 | 1741.0 | „ |
| 56.131 | 760.00 | „ | 87.967 | 2026.3 | „ |
| 61.362 | 906.1 | „ | 93.377 | 2347.4 | „ |
| 28.15 | 258.8 | Beckmann and Faust | 20 | 179.6 | Fischer and Zerbe (1923) |
| 40.10 | 425.0 | „ (1914) | | | |
| 55.40 | 741.8 | „ | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 56°1 | Barr and Bircumshaw (1921) | 56°20 | B.E. (1928) |
| 56°11 | Clusius and Ringer (1940) | 56°20 | Rosanoff and Easley (1909) |
| 56°13 | Zmaczynski (1930) | 56°20 | Dutoit and Friederich (1900) |
| 56°15 | Grimm and Patrick (1923) | 56°22 | Mac Ewen (1923) |
| 56°15 | Lecat (passim) | 56°25 | Young (1933) |
| | | 56°3 | Jones (1929) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°38<br>0°386 | Crafts (1887)<br>Zmaczynski (1930) | 0°39 | B.E. (1928) and Lecat (passim) |

*Freezing point*

| | | | |
|---|---|---|---|
| −94°82 | Clusius and Ringer (1940) | −94°9 | Mac Neight and Smyth (1936) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −94.5 | 0.91567 | Timmermans (1912) | −37.2 | 0.85337 | Timmermans (1912) |
| −83.4 | 0.90321 | „ | −30.6 | 0.84603 | „ |
| −73.95 | 0.89289 | „ | −22.95 | 0.83754 | „ |
| −63.3 | 0.88150 | „ | −13.1 | 0.82701 | „ |
| −53.6 | 0.87132 | „ | − 6.2 | 0.81943 | „ |
| −45.0 | 0.86198 | „ | 0 | 0.81248 | „ |
| 0 | 0.81250 | B.E. (1928) | 20 | 0.79082 | Price (1919) |
| 15 | 0.79597 | „ | 30 | 0.77931 | „ |
| 30 | 0.77933 | „ | 40 | 0.76784 | „ |
| 15 | 0.79574 | Timmermans (1910) | 50 | 0.75599 | „ |
| 20 | 0.79053 | Zmaczynski (1930) | 20 | 0.79053 | Young (1933) |
| 20 | 0.79060 | Grünert (1927) | 25 | 0.78502 | Barr and Bircumshaw |
| 40 | 0.76820 | „ | 25 | 0.78502 | Lewis (1924) (1921) |
| 0 | 0.81252 | Richards and Shipley (1916) | 25 | 0.78503 | Hughes and Hartley (1933) |
| | | | 25 | 0.7846 | Albright (1937) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 0 | 398 | Lacher, Walden and Park |
| 15 | 337.1 | B.E. (1928) (1949) |
| 30 | 295.4 | „ |
| 25 | 307.5 | Hughes and Hartley (1933) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 23.92 | Hennaut-Roland and Lek |
| 20 | 23.32 | „ (1931) |
| 30 | 22.01 | „ |

*Refractive index*

| t° | Hα | D | He y. | Hβ | |
|---|---|---|---|---|---|
| 15 | 1.35959 | 1.36157 | 1.36176 | 1.36634 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00049 | 50 | 50 | 50 | „ |
| 17.5 | 1.35832 | — | — | 1.36515 | Guillery (1930) (+ other values) |
| 20 | — | 1.35911 | — | — | Pahlavouni (1927) |
| 25 | — | 1.35662 | — | — | Rosanoff, Bacon and White (1914) |

*Magnetic rotatory power:* 20° 3.50 Lowry (1914)

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −203.5 | 0.219 | −182.3 | 0.257 | −168.8 | 0.278 | Parks and Kelly |
| −198.9 | 0.229 | −181.9 | 0.259 | −167.8 | 0.281 | „ (1925) |
| −193.4 | 0.239 | −177.9 | 0.266 | −121.9 | 0.350 | „ |
| −187.6 | 0.250 | −173.0 | 0.272 | −120.1 | 0.352 | „ |
| −76.5 | 0.480 | + 3.8 | 0.507 | 10.3 | 0.509 | „ |
| −73.0 | 0.482 | 6.2 | 0.508 | 16.3 | 0.513 | „ |
| −55.6 | 0.485 | | | | | „ |
| L. 23.54 | 0.519 | 34.65 | 0.527 | 46.30 | 0.536 | Tréhin (1921) |
| 28.03 | 0.518 | 38.26 | 0.527 | | | „ |
| 32.07 | 0.526 | 42.71 | 0.529 | | | „ |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P) 125.3 cal 15°/g | Grimm and Patrick (1923) |
| *Heat of melting* | 23.42 „ | Parks and Kelley (1925) |
| *Heat of combustion* | 25° ($c_p$) 7365.3 „ | Miles and Herschel Hunt (1941) (M.W.: 58.0786) |

# DIETHYLKETONE $C_2H_5.CO.C_2H_5$

**Constants:** B.E. (1932)

*Boiling point*

| | | | |
|---|---|---|---|
| 102°00 | $\frac{dt}{dp}$ *(10 mm):* | 0°38 | B.E. (1932) |
| 102°05 | „ | 0°38 | Lecat (passim) |
| 102°35 | | | Eykman (1919) |

*Freezing point* —39°9 B.E. (1932)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.83353 | B.E. (1932) | 10 | 0.8243 | Gross, Rintelen and |
| 15 | 0.81907 | „ | 30 | 0.8045 | „ Saylor (1939) |
| 30 | 0.80461 | „ | 50 | 0.7867 | „ |
| 24.80 | 0.8097 | Owen, Quayle and Clegg | 17.6 | 0.8163 | Eykman (1919) |
| 34.85 | 0.8000 | „ (1942) | 20 | 0.8141 | Gartenmeister (1890) |
| 50.15 | 0.7848 | „ | | | |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|---|---|
| 15 | 493 | 15 | 25.87 | B.E. (1932) | 24.80 | 24.73 | Owen, Quayle and Clegg |
| 30 | 423 | 20 | 25.26 | „ | 34.85 | 23.74 | „ (1942) |
| | | 30 | 24.37 | „ | 50.15 | 22.11 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.39242 | 1.39272 | 1.39496 | 1.39884 | 1.39983 | 1.40278 | — | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00046 | 45 | 45 | 46 | 47 | 46 | — | „ |
| 17.6 | 1.39148 | 1.39176 | 1.39383 | 1.39774 | 1.39871 | 1.40162 | 1.40277 | Eykman (1919) |

## DI-*n*-PROPYLKETONE $(n\text{-}C_3H_7)_2CO$

### Constants

*Boiling point* — *Freezing point*

| | | | | |
|---|---|---|---|---|
| 143°52 | $\frac{dt}{dp}$ *(10 mm):* 0°48 | Louguinine (1898) | —32°5 | Timmermans (passim) |
| 143°55 | | Lecat (passim) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 14.8 | 0.8203 | Perkin (1896) | 15.1 | 0.8205 | Eykman (1893–1919) |
| 90 | 0.7534 | „ | 22 | 0.8160 | Errera and Sherrill (1930) |

*Viscosity:* 20° $751 \cdot 10^{-5}$ Gartenmeister (1890)

*Refractive index*

| t° | Hα | Hβ | |
|---|---|---|---|
| 15°1 | 1.40818 | 1.41538 | Eykman (1893) |

*Molecular magnetic rotatory power*

| | | | | | |
|---|---|---|---|---|---|
| 15° | 7.471 | Lowry (1914) | 14°8 | 7.471 | Perkin (1896) |
| 20° | 7.44 | „ | 90°0 | 7.377 | „ |

DI-*n*-BUTYLKETONE has not been thoroughly studied.

## DI-*iso*-BUTYLKETONE $(CH_3)_2.CH.CH_2.CO.CH_2.CH.(CH_3)_2$

**Constants:** Stross, Gable and Rounds (1947)

*Saturated vapour pressure* — *Boiling point* — *Freezing point*

| t° | p mm | | |
|---|---|---|---|
| 86.41 | 50 | 168°24 | −46°04 |
| 103.54 | 100 | | |

*Density*

| t° | d |
|---|---|
| 20.00 | 0.80600 |
| 40.00 | 0.78995 |
| 60.00 | 0.77379 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 0 | 1320 |
| 20 | 930 |
| 30 | 765 |
| 40 | 665 |

*Refractive index*

| t° | Hα | D | Hβ |
|---|---|---|---|
| 20.00 | 1.41012 | 1.41225 | 1.41751 |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 168°24 | 60.33 | cal 15°/g |
| | 103°54 | 67.66 | „ |
| | 86°41 | 69.68 | „ |

## DI-*n*-AMYLKETONE $(n\text{-}C_5H_{11})_2CO$

**Constants:** Simon (1929)

*Boiling point:* 228°0 *Freezing point:* 14°6 Timmermans (passim)

*Density*

| t° | d | |
|---|---|---|
| 15 | 0.82862 | Simon (1929) |
| 30 | 0.80680 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1951 | Simon (1929) |
| 30 | 1768 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42805 | 1.42841 | 1.43069 | 1.43079 | 1.43512 | 1.43613 | 1.43946 | 1.44106 |
| $\frac{dn}{dt}$ | 0.000385 | 387 | 387 | 384 | 395 | 396 | 389 | 396 |

Eykman (1919) and Krafft (1882) have measured the density, the freezing point and the refractive index of the following compounds: Dihexylketone: $(C_6H_{13})_2$—CO; Dilaurylketone: $(C_{11}H_{23})_2$—CO; Dipalmitylketone: $(C_{15}H_{31})_2$—CO. As other data are lacking, these results cannot be considered as absolutely reliable.

### METHYLKETONES.

The methylketones, from $C_2$ to $C_{11}$, were prepared by Ceuterick (1936) starting from substituted acetylacetic esters and also by catalytic reaction of mixtures of acetic acid and homologous acids. All the compounds must be purified by using the bisulphite compound, followed by fractional distillation until constancy of density for successive fractions is attained. For the $C_4$ and $C_5$ terms, the last traces of moisture must be eliminated by drying the vapour over $P_2O_5$.

## METHYLETHYLKETONE $CH_3.CO.C_2H_5$

Commercial methylethylketone is available in a fairly pure state. It can be purified by using the additive reaction with NaI (Lochte, 1924). Water is easily eliminated by distillation owing to the existence of an azeotrope (B.P.: 73°6).

**Constants:** B.E. (1928)

*Boiling point*

| | | | |
|---|---|---|---|
| 79°57 | Marshall (1906) | 79°60 | $\frac{dt}{dp}$ *(10 mm):* 0°38 B.E. (1928) and Lecat (passim) |
| 79°6 | Ceuterick (1936) | | |
| 79°60 | Grimm and Patrick (1923) | 79°89 | Mascarelli and Musatty (1911) |

*Freezing point*

| | | | |
|---|---|---|---|
| −86°4 | B.E. (1928) | −86°9 | Doolittle (1944) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.82555 | B.E. (1928) | 15 | 0.81005 | Marshall (1906) |
| 15 | 0.81010 | „ | 15.4 | 0.8096 | Eykman (1893) |
| 30 | 0.79452 | „ | 15 | 0.81010 | Ceuterick (1936) |
| | | | 30 | 0.79452 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 423 | B.E. (1928) |
| 30 | 365 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.37882 | 1.37927 | 1.38140 | 1.38151 | 1.38530 | 1.38628 | 1.38916 | 1.39014 | B.E. (1928) |
| $\frac{\Delta n}{\Delta t}$ | 0.00047 | 47 | 48 | 48 | 48 | 48 | 48 | 48 | „ |
| 15 | — | 1.37910 | 1.38101 | — | — | 1.38597 | — | 1.38997 | Ceuterick (1936) |
| 30 | — | 1.37217 | 1.37412 | — | — | 1.37890 | — | 1.38285 | „ |
| $\frac{\Delta n}{\Delta t}$ | — | 0.00046 | 46 | — | — | 47 | — | 48 | „ |
| 20 | — | — | 1.3786 | — | — | — | — | — | Doolittle (1944) |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 103.45 cal 15°/g | Grimm and Patrick (1923) |

## HIGHER METHYLALKYLKETONES

**Constants** CEUTERICK (1936):

| | B.P. | F.P. |
|---|---|---|
| R=*n*-propyl<br>*n*-$C_3H_7$ | 102°35 LECAT (passim)<br>102°4 BONINO (1925) | −77°75 TIMMERMANS (pass |
| R=*n*-butyl<br>*n*-$C_4H_9$ | 127°2 LECAT (passim) | −56°9 TIMMERMANS (passi<br>−55°8 DOOLITTLE (1944) |
| R=*n*-hexyl<br>*n*-$C_6H_{13}$ | 172°85 LECAT (passim) | −21°5 CEUTERICK (1936)<br>−20°5 DOOLITTLE (1944) |
| R=*n*-heptyl<br>*n*-$C_7H_{15}$ | 73°8/10 mm CEUTERICK (1936) | − 7°8 CEUTERICK (1936) |
| R=*n*-octyl<br>*n*-$C_8H_{17}$ | 90°5/10 mm ,, | 3°1 ,, |
| R=*n*-nonyl<br>*n*-$C_9H_{19}$ | 106°1/10 mm ,, | 12°7 ,,<br>12°8 DOOLITTLE (1944) |
| R=*n*-decyl<br>*n*-$C_{10}H_{21}$ | 119°0/10 mm ,, | 20°5 CEUTERICK (1936) |
| R=*n*-undecyl<br>*n*-$C_{11}H_{23}$ | 133°6/10 mm ,, | 28°1 ,, |

$CH_3.CO.R$

| Density | | | Refractive index | | | | |
|---|---|---|---|---|---|---|---|
| | | | | 15° | 30° | $\frac{dn}{dt}$ | |
| 15° | 0.81130 | CEUTERICK (1936) | Hα | 1.39030 | 1.38379 | 0.00043 | CEUTERICK (1936) |
| 30° | 0.79656 | „ | D | 1.39229 | 1.38579 | 43 | |
| | | | Hβ | 1.39730 | 1.39072 | 44 | |
| | | | Hγ | 1.40138 | 1.39475 | 44 | |
| 15° | 0.81581 | | Hα | 1.40061 | 1.39452 | 0.00041 | „ |
| 30° | 0.80220 | | D | 1.40273 | 1.39661 | 41 | |
| 10° | 0.8198 | GROSS, RINTELEN | Hβ | 1.40790 | 1.40164 | 42 | |
| 30° | 0.8025 | and SAYLOR (1939) | Hγ | 1.41212 | 1.40588 | 42 | |
| 50° | 0.7845 | „ | D | (20°) 1.4008 DOOLITTLE (1944) | | | |
| 15° | 0.82268 | CEUTERICK (1936) | Hα | 1.41504 | 1.40892 | 0.00041 | „ |
| 30° | 0.81023 | „ | D | 1.41722 | 1.41111 | 41 | |
| | | | Hβ | 1.42241 | 1.41619 | 42 | |
| | | | Hγ | 1.42682 | 1.42036 | 43 | |
| | | | D | (20°) 1.4155 DOOLITTLE (1944) | | | |
| 15° | 0.82536 | „ | Hα | 1.42153 | 1.41443 | 0.00041 | „ |
| 30° | 0.81327 | „ | D | 1.42271 | 1.41675 | 40 | |
| | | | Hβ | 1.42805 | 1.42204 | 40 | |
| | | | Hγ | 1.43243 | 1.42638 | 40 | |
| 15° | 0.82765 | „ | Hα | 1.42495 | 1.41912 | 0.00039 | „ |
| 30° | 0.81579 | „ | D | 1.42720 | 1.42128 | 39 | |
| | | | Hβ | 1.43248 | 1.42664 | 39 | |
| | | | Hγ | 1.43684 | 1.43112 | 38 | |
| 15° | 0.82945 | „ | Hα | 1.42860 | 1.42309 | 0.00037 | „ |
| 30° | 0.81801 | „ | D | 1.43085 | 1.42527 | 37 | |
| | | | Hβ | 1.43633 | 1.43071 | 38 | |
| | | | Hγ | 1.44063 | 1.43509 | 37 | |
| | | | D | (20°) 1.4291 DOOLITTLE (1944) | | | |
| 30° | 0.81982 | „ | Hα | — | 1.42638 | — | „ |
| | | | D | — | 1.42855 | — | |
| | | | Hβ | — | 1.43398 | — | |
| | | | Hγ | — | 1.43847 | — | |
| 30° | 0.82168 | „ | Hα | — | 1.42951 | — | „ |
| | | | D | — | 1.43175 | — | |
| | | | Hβ | — | 1.43719 | — | |
| | | | Hγ | — | 1.44166 | — | |

## METHYL-*n*-AMYLKETONE $CH_3.CO.n\text{-}C_5H_{11}$

### Constants

*Boiling point*

| | |
|---|---|
| 151°45 | Simon (1929) |

*Freezing point*

| | |
|---|---|
| −35°0 | Doolittle (1944) |
| −35°6 | Simon (1929) |

*Density*

| t° | d | |
|---|---|---|
| 15 | 0.81966 | Ceuterick (1936) |
| 30 | 0.80675 | „ |

| t° | d | |
|---|---|---|
| 0 | 0.83239 | Simon (1929) |
| 15 | 0.81966 | „ |
| 30 | 0.80680 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 854 | Simon (1928) |
| 30 | 686 | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.40872 | 1.41086 | 1.41609 | 1.42029 | Ceuterick (1936) |
| 30 | 1.40236 | 1.40439 | 1.40947 | 1.41374 | „ |
| $\frac{dn}{dt}$ | 42 | 43 | 44 | 44 | „ |
| 20 | — | 1.4088 | — | — | Doolittle (1944) |

The values of Ceuterick seem better than those of Simon, which are probably affected by a systematic error.

ETHYL-*n*-PROPYLKETONE: $C_2H_5.CO.n\text{-}C_3H_7$

ETHYL-*n*-PENTADECYLKETONE: $C_2H_5.CO.n\text{-}C_{15}H_{31}$.

These compounds were studied by Eykman (1919) and Krafft (1879), but there are not sufficient criteria for the purity of their products.

| | | | | |
|---|---|---|---|---|
| ETHYL-*n*-PROPYLKETONE | $C_2H_5.CO.C_3H_7$ | Owen, Quayle and Clegg (1942) | | |
| „ *n*-BUTYL | „ | „ | $C_4H_9$ | „ |
| „ *n*-AMYL | „ | „ | $C_5H_{11}$ | „ |
| *n*-PROPYL-*n*-BUTYL | „ | $C_3H_7.CO.C_4H_9$ | | |
| *n*-BUTYL-*n*-AMYL | „ | $C_4H_9.CO.C_5H_{11}$ | | |

2,2,4-TRIMETHYLPENTANONE-3 $C(CH_3)_3.CO.CH(CH_3)_2$

2,2,4,4-TETRAMETHYLPENTANONE-3 $C(CH_3)_3.CO.C(CH_3)_3$

*Boiling* and *freezing points, density* and *refractive index:* HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947).

4-METHYLPENTEN-3-ONE-2 or MESITYLOXIDE $(CH_3)_2C=CH.CO.CH_3$

4-METHYLPENTEN-4-ONE-2 or *Iso*-MESITYLOXIDE $CH_2=C(CH_3).CH_2.CO.CH_3$

*Critical constants, saturated vapour pressure, boiling* and *freezing points, density, viscosity, surface tension, refractive index* and *heat of vaporisation:* STROSS, MONGER and FINCH (1947).

## E. OXIDES

### CARBON MONOXIDE CO

This substance is prepared by one of the following methods: the reaction of $P_2O_5$ on sodium formate; dehydration of formic acid by phosphoric or sulphuric acid; or by the reaction of concentrated sulphuric acid on potassium ferrocyanide. The gas is purified by bubbling through a solution of KOH and drying over KOH and $P_2O_5$, followed by fractional distillation. (MOLES and SALAZAR, 1932).

#### Constants. — Polyphasic equilibria

The thermometric scales used are: the Leyden scale: 0°C = 273°09 K (CROMMELIN and his collaborators; VERSCHOYLE; CLUSIUS and his collaborators and KAISCHEW); the American scale: 0°C = 273°16 K (CLAYTON and GIAUQUE).

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| −140.21 | 34.529 | 0.3010 | CROMMELIN, BYLEVELD and BROWN (1931) and MATHIAS, CROMMELIN, BYLEVELD and GRIGG (1932) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|
| −141.73 | 0.42200 | 0.19392 | −169.61 | 0.68560 | 0.02824 | Mathias, Crommelin, Byleveld and Grigg (1932) corr. by Mathias and Crommelin (1936) |
| −142.26 | 0.43365 | 0.18462 | −172.18 | 0.69953 | 0.02389 | |
| −142.56 | 0.44026 | 0.17767 | −178.95 | 0.73408 | — | |
| −143.31 | 0.45640 | 0.16357 | −182.83 | 0.75446 | — | |
| −145.30 | 0.49190 | 0.13601 | −185.96 | 0.76904 | — | ,, |
| −147.51 | 0.52083 | 0.11607 | −190.86 | 0.79086 | — | ,, |
| −152.21 | 0.56582 | 0.08202 | −195.08 | 0.80640 | — | ,, |
| −164.06 | 0.65262 | 0.04014 | −199.54 | 0.82554 | — | ,, |
| −165.50 | 0.66168 | 0.03681 | −204.97 | 0.84714 | — | ,, |

*Rectilinear diameter*: $0.55505 - 0.001912\ T^{\circ} - 7 \cdot 10^{-9}(T^{\circ} - 100)$ Mathias (1935)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. −212.754 | 20.41 | L. −203.355 | 151.84 | −197.086 | 379.95 | Clusius and Teske |
| −211.105 | 30.83 | −202.289 | 178.11 | −196.665 | 396.91 | ,, (1929) |
| −208.198 | 60.99 | −201.633 | 197.95 | −196.516 | 408.78 | ,, |
| −206.789 | 79.65 | −200.752 | 228.30 | −195.593 | 464.82 | ,, |
| −205.727 | 99.63 | −199.681 | 265.21 | −195.591 | 464.92 | ,, |
| −204.877 | 117.08 | −199.096 | 287.45 | −194.825 | 510.62 | ,, |
| | | −198.371 | 318.97 | −194.262 | 546.20 | ,, |
| | | −198.312 | 321.44 | −193.394 | 606.66 | ,, |
| | | −197.532 | 356.50 | −193.123 | 624.18 | ,, |
| | | −197.459 | 361.80 | | | ,, |
| C. −216.23 | 7.21 | L. −204.95 | 116.15 | −165.47 | 6897.78 | Crommelin, Byleveld and Brown |
| −210.41 | 36.46 | −204.92 | 116.88 | −160.89 | 9168.68 | ,, (1931) |
| −208.13 | 60.71 | −199.24 | 282.51 | −149.63 | 16824.44 | ,, |
| −207.42 | 70.52 | −195.13 | 490.38 | −147.13 | 18998.13 | ,, |
| −206.46 | 80.99 | −191.64 | 745.30 | −143.86 | 22165.25 | ,, |
| −205.95 | 97.72 | −185.48 | 1430.42 | −141.27 | 24995.90 | ,, |
| −205.19 | 110.63 | −178.75 | 2628.74 | −140.62 | 25748.57 | ,, |
| −205.02 | 114.83 | −169.61 | 5257.26 | | | ,, |
| | | | | | | ,, |
| C. −218.88 | 3.26 | L. −202.27 | 180.09 | −192.07 | 709.0 | |
| −215.70 | 8.88 | −199.33 | 279.1 | −190.87 | 813.2 | Verschoyle (1931) |
| −212.78 | 19.80 | −196.55 | 407.8 | −188.06 | 1100.9 | ,, |
| −210.81 | 33.00 | −193.95 | 566.0 | −185.44 | 1431.5 | ,, |
| −207.43 | 70.43 | | | | | ,, |
| −205.01 | 115.95 | | | | | ,, |
| | | | | | | ,, |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. −212.92 | 19.98 | L. −205.07 | 115.30 | −197.726 | 352.22 | Clayton and Giauque (1932) |
| −211.61 | 28.11 | −204.059 | 136.51 | −196.809 | 397.84 | Giauque (1932) |
| −210.94 | 32.75 | −203.268 | 155.58 | −195.893 | 448.59 | „ |
| −209.86 | 42.30 | −202.470 | 176.41 | −195.050 | 499.34 | „ |
| −208.85 | 52.83 | −200.933 | 223.64 | −194.212 | 554.06 | „ |
| −207.88 | 65.46 | −199.914 | 259.71 | −193.302 | 618.71 | „ |
| −207.04 | 77.69 | −199.300 | 283.25 | −192.058 | 716.89 | „ |
| −206.14 | 93.25 | −198.574 | 313.47 | −189.928 | 902.06 | „ |
| | | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| −191°37 | Clusius and Teske (1929) | −191°47 | Crommelin, Byleveld and Brown (1931) |
| −191°47 | Verschoyle (1931) | −191°55 | Clayton and Giauque (1932) |

*Triple point*

| | |
|---|---|
| −204°87/115.376 mm | Clusius and Teske (1929) and Clusius (1941) |
| −204°99/115.1096 mm | Crommelin, Byleveld and Brown (1931) |
| −204°99/115.4 mm | Kaischew (1938) |
| −205°03/114.86 mm | Verschoyle (1931) |
| −205°07/115.31 mm | Clayton and Giauque (1932) |

*Melting curve*

| t° | p atm. | | t° | p atm. | |
|---|---|---|---|---|---|
| −205.03 | 0.15 | Verschoyle (1931) | −201.505 | 157.06 | Verschoyle (1931) |
| −203.745 | 55.53 | „ | −200.435 | 205.44 | „ |
| −202.66 | 103.86 | „ | | | |

*Transition point*

| | | | |
|---|---|---|---|
| −211°61 | Clayton and Giauque (1932) | −211°60 | Kaischew (1938) |
| | | −211°59 | Clusius (1929) |

## Constants of state

*Weight of the normal litre in the gaseous state*

| | |
|---|---|
| 1.25001 ± 0.00001 | Moles and Salazar (1934) |

*Deviation from Avogadro's law:* $A_0^1 = 1.00040 \pm 0.00002$ Moles and Salazar (1934)

This value corrects the following values: Moles and Salazar (1932) and Pire and Moles (1929); it agrees with the value at 0°: 1.00048 given by Schlätter (1923) and (1930).

*Expansion coefficient*

| | |
|---|---|
| (11°03 → 48°01): 3669.4 · $10^{-6}$ 413 mm | Coppock and Whytlaw Gray (1934) |
| „ 3674.4 „ /768 mm | „ |
| (−16°42 → −190°15): 3736.08 „ | Estreicher and Bobotek (1913) |
| (+16°30 → −150°38): 3721.79 „ | „ |
| (+18°37 → − 80°38): 3716.21 „ | „ |
| (+18°48 → 0° ): 3681.56 „ | „ |
| ( 0° → −80°38): 3724.07 „ | „ |
| (−80°38 → −150°38): 3729.63 „ | „ |
| (−150°38 → −190°15): 3796.71 „ | „ |

*Isotherms of compressibility*

| | |
|---|---|
| (0° → 20° and 50 → 130 atm.) | Botella (1929) |
| (0° → 20° and 1 → 125 atm.) | Goïg (prelim. note), (1929) and (1930); Bartlett, Hetherington, Kvalnes and Tremearne (1930) |

## Heat constants

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|---|
| C. II | −261.20 | 0.04335 | −239.99 | 0.2411 | C. I −209.19 | 0.4311 | Clusius (1929) |
| | −259.66 | 0.06128 | −237.39 | 0.2625 | −207.89 | 0.4371 | „ |
| | −257.74 | 0.07435 | −234.59 | 0.2835 | −206.89 | 0.4411 | „ |
| | −256.90 | 0.08235 | −231.49 | 0.3085 | L. −202.99 | 0.5118 | „ |
| | −255.01 | 0.09525 | −228.39 | 0.3271 | −198.89 | 0.5157 | „ |
| | −253.56 | 0.1084 | −225.49 | 0.3514 | −196.79 | 0.5189 | „ |
| | −253.09 | 0.1142 | −222.59 | 0.3743 | −193.09 | 0.5236 | „ |
| | −251.19 | 0.1333 | −220.29 | 0.3982 | −191.79 | 0.5268 | „ |
| | −249.19 | 0.1537 | −217.89 | 0.4250 | | | „ |
| | −244.39 | 0.2074 | −216.09 | 0.4576 | | | „ |
| | −242.19 | 0.2231 | | | | | „ |

*Specific heat* (continued)

| | | | | | | |
|---|---|---|---|---|---|---|
| C. II | −258.80 | 0.05846 | −228.45 | 0.3246 | L. −203.14 | 0.5150 | CLAYTON and GIAUQUE (1932) |
| | −256.22 | 0.08778 | −225.26 | 0.3531 | −200.99 | 0.5153 | |
| | −253.79 | 0.1167 | −224.82 | 0.3545 | −197.69 | 0.5171 | „ |
| | −251.23 | 0.1420 | −220.82 | 0.3932 | −197.36 | 0.5139 | „ |
| | −248.85 | 0.1633 | −218.09 | 0.4189 | −194.38 | 0.5146 | „ |
| | −246.52 | 0.1825 | −216.34 | 0.4539 | −194.10 | 0.5171 | „ |
| | −244.15 | 0.2029 | −214.12 | 0.4857 | −192.55 | 0.5178 | „ |
| | −241.60 | 0.2240 | C. I −209.69 | 0.4293 | −189.77 | 0.5143 | „ |
| | −233.31 | 0.2896 | −208.61 | 0.4328 | −188.50 | 0.5161 | „ |
| | −228.95 | 0.3234 | −207.14 | 0.4393 | | | „ |
| C. II | −218.87 | 0.4136 | C. I −209.83 | 0.4307 | L. −202.16 | 0.5114 | KAISCHEW(1938) |
| | −216.72 | 0.4396 | −208.94 | 0.4318 | −201.88 | 0.5143 | „ |
| | −216.43 | 0.4482 | −207.41 | 0.4396 | −200.85 | 0.5107 | „ |
| | −214.76 | 0.4750 | −206.76 | 0.4414 | −199.51 | 0.5121 | „ |
| | −214.58 | 0.4803 | | | −199.50 | 0.5125 | „ |
| | −213.85 | 0.4903 | | | −199.29 | 0.5139 | „ |
| | | | | | −198.71 | 0.5153 | „ |
| | | | | | −197.58 | 0.5143 | „ |
| | | | | | −197.28 | 0.5125 | „ |

N.B. For the liquid, these results agree sufficiently, considering the experimental difficulties.

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | (B.P.) | 51.557 cal 15°/g | CLAYTON and GIAUQUE (1932) |
| *Heat of melting* | | 7.132 „ | „ |
| | | 7.175 „ | KAISCHEW (1938) |
| | | 7.196 „ | CLUSIUS (1929) |
| *Heat of transition* | | 5.389 „ | KAISCHEW (1938) |
| | | 5.400 „ | CLUSIUS (1929) |
| | | 5.403 „ | CLAYTON and GIAUQUE (1932) |
| *Heat of combustion* | 25° ($c_p$) | 2.4152 „ | ROSSINI (1931) |

## CARBON DIOXIDE $CO_2$

Prepared by decomposition of $NaHCO_3$ by heat. The gas is purified by bubbling through $H_2SO_4$ and drying over $P_2O_5$, followed by fractional distillation. (CARDOSO and BELL, 1912, GUYE and PINTZA, 1905–07).

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. atm. | d cr. | |
|---|---|---|---|
| 30.96 | — | — | KENNEDY (1929) |
| — | — | 0.4587 | KEYES and KENNEDY (1917) |
| 30.98 | 72.93 | 0.468 | KEESOM (1903) |

*Critical constants* (continued)

| t° cr. | p cr atm. | d cr. | |
|---|---|---|---|
| 30.985 | — | 0.460 | Kamerlingh Onnes and Fabius (1906-07) |
| 31.00 | 72.85 | — | Cardoso and Bell (1912) |
| 31.00 | — | — | Verschaffelt (1896) |
| 31.00 | 72.80 | — | Meyers and Van Dusen (1933) |
| 31.04 | 72.85 | 0.467 | Michels (1937) |
| 31.10 | 73.00 | 0.459 | Dorsman (1908) |
| 31.12 | — | — | Brinkman (1904) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|
| 22.9 | 0.7422 | 0.2163 | 6.2 | 0.8878 | 0.1217 | Lowry and Erickson (1927) |
| 17.2 | 0.8045 | 0.1721 | 1.2 | 0.9198 | 0.1029 | ,, |
| 15.2 | 0.8216 | 0.1607 | −1.8 | 0.9378 | 0.0940 | ,, |
| 11.2 | 0.8547 | 0.1390 | −5.8 | 0.9604 | 0.0803 | ,, |
| 2.853 | 0.91299 | 0.10684 | 28.052 | 0.65578 | 0.28956 | Michels (1937) |
| 10.822 | 0.85724 | 0.13881 | 29.929 | 0.59509 | 0.34064 | ,, |
| 19.874 | 0.77698 | 0.19299 | 30.409 | 0.57393 | 0.36026 | ,, |
| 25.070 | 0.71134 | 0.24252 | 31.013 | 0.51205 | 0.42783 | ,, |
| 25.298 | 0.70719 | 0.24608 | | | | ,, |

*Saturated vapour pressure*

| t° | p mm · $10^4$ | t° | p mm · $10^4$ | t° | p mm · $10^4$ | |
|---|---|---|---|---|---|---|
| C. −183.0 | 0.06 | −171.01 | 3.03 | −167.04 | 9.825 | Kamerlingh Onnes and Weber (1913) |
| −175.37 | 0.795 | −168.83 | 5.93 | | | |
| C. −168.83 | 6.01 | −158.55 | 209.6 | −140.63 | 3822 | Weber (1913) |
| −164.03 | 22.5 | −155.00 | 359.1 | −138.69 | 5401 | ,, |
| −163.19 | 28.2 | −148.27 | 882.90 | −136.78 | 9514.1 | ,, |
| −161.39 | 44.4 | −145.44 | 1537 | −134.67 | 10728 | ,, |
| −159.72 | 66.0 | −143.07 | 2428 | | | ,, |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. −127.21 | 3.50 | −99.27 | 112.66 | −82.60 | 538.4 | Siemens (1913) |
| −122.11 | 7.36 | −98.06 | 127.77 | −81.86 | 573.2 | ,, |
| −117.77 | 13.09 | −95.02 | 172.9 | −80.85 | 622.7 | ,, |
| −116.33 | 15.79 | −92.65 | 217.1 | −80.04 | 667.1 | ,, |
| −113.51 | 22.65 | −89.88 | 283.1 | −79.59 | 692.1 | ,, |
| −110.56 | 32.19 | −87.58 | 348.9 | −79.05 | 723.0 | ,, |
| −106.63 | 50.39 | −87.09 | 364.1 | −78.46 | 759.7 | ,, |
| −101.57 | 88.44 | −84.46 | 459.4 | −77.38 | 830.1 | ,, |
| C. −118.964 | 11.32 | −102.469 | 80.39 | −85.804 | 407.18 | Giauque and Egan |
| −114.757 | 19.40 | −98.472 | 122.20 | −80.497 | 643.36 | ,, (1937) |
| −110.563 | 32.21 | −94.591 | 179.94 | −78.178 | 771.62 | ,, |
| −106.456 | 51.86 | −90.827 | 257.85 | −77.329 | 835.30 | ,, |
| C. −109.74 | 35.7 | −87.52 | 350.3 | −63.13 | 2800.600 | Kuenen and Robson |
| −108.97 | 38.9 | −78.32 | 760.000 | −62.47 | 2894.840 | ,, (1902) |
| −108.73 | 40.1 | −76.90 | 814.720 | −61.60 | 3033.160 | ,, |
| −102.96 | 76.6 | −71.41 | 1279.080 | −61.41 | 3053.680 | ,, |
| − 98.89 | 117.7 | −63.36 | 2378.040 | −57.87 | 3606.960 | ,, |
| − 95.92 | 158.7 | −61.80 | 2584.320 | −57.80 | 3604.680 | ,, |
| − 87.91 | 338.5 | −57.86 | 2720.800 | −56.24 | 3876.00 | ,, |
| C. −87.50 | 351.7 | −83.50 | 500.0 | −79.50 | 697.2 | Thiele and Schulte |
| −87.00 | 369.4 | −83.00 | 521.3 | −79.00 | 725.6 | ,, (1920) |
| −86.50 | 387.2 | −82.50 | 543.6 | −78.61 | 750.0 | ,, |
| −86.00 | 404.9 | −82.00 | 566.6 | −78.50 | 757.2 | ,, |
| −85.50 | 422.5 | −81.50 | 590.8 | −78.46 | 760.0 | ,, |
| −85.00 | 440.3 | −81.00 | 615.3 | −78.00 | 789.1 | ,, |
| −84.50 | 458.0 | −80.50 | 641.9 | −77.50 | 821.5 | ,, |
| −84.00 | 479.0 | −80.00 | 669.1 | −77.00 | 854.5 | ,, |
| C. −78.797 | 742.44 | −70.005 | 1475.9 | −59.851 | 3104.46 | Meyers and Van |
| −78.559 | 757.1 | −69.537 | 1538.7 | −56.760 | 3845.6 | Dusen (1926) |
| −78.506 | 760.5 | −60.265 | 3017.2 | −56.653 | 3871.0 | ,, |
| −77.800 | 804.7 | −60.222 | 3024.8 | −56.629 | 3878.69 | ,, |
| −70.148 | 1469.83 | −60.134 | 3044.74 | | | ,, |
| L. −56.18 | 3876.0 | −33.08 | 9568.4 | −15.27 | 16894.8 | Kuenen and Robson |
| −54.60 | 4102.0 | −32.68 | 9576.0 | − 9.95 | 19775.2 | ,, (1902) |
| −47.58 | 5578.4 | −27.01 | 11719.2 | | | ,, |
| −41.02 | 7189.6 | −21.67 | 13923.2 | | | ,, |

*Saturated vapour pressure* (continued)

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| L. | −56.476 | 3905.4 | −35.002 | 9028.6 | 24.998 | 48248 | Meyers and Van Dusen (1926) |
| | 55.221 | 4122.1 | 30.005 | 10716.8 | 25.018 | 48260 | |
| | −50.781 | 4965.7 | 0 | 26140.0 | 29.986 | 54054 | „ |
| | −50.534 | 5015.6 | + 5.001 | 29771.4 | 30.950 | 55274 | „ |
| | −50.002 | 5127.6 | 9.995 | 33759.4 | 31.081 | 55438 | „ |
| | −45.011 | 6246.8 | 15.000 | 38148.9 | | | „ |
| | −40.005 | 7543.6 | 20.000 | 42960 | | | „ |
| L. | 2.853 | 28117.72 | 25.070 | 48226.56 | 29.929 | 53961.52 | Michels (1937) |
| | 10.822 | 34398.36 | 25.298 | 48481.16 | 30.409 | 54552.80 | „ |
| | 19.874 | 42763.68 | 28.052 | 51692.92 | 31.013 | 55325.72 | „ |
| L. | 0 | 26144.7 | | | | | Bridgeman (1927) |

*Isotherms*

Near the critical point and the coexistence curve: Michels, Blaisse and Michels (1937)

Between 25° → 60° and from 60 to 140 atm. Keesom (1903)
„ 25° and 150° and above 3000 atm. Michels, Blijl and Michels (1937)
„ 0° „ „ „ „ „ Michels and Michels (1937)
„ „ „ „ „ below „ Michels (1937)
„ −37° „ +30° „ between 10 and 70 kg/cm²: Jenkins (1921)

*Thermodynamical properties as function of density, temperature* and *pressure:* Michels and De Groot (1948)

*Triple point*

| | | |
|---|---|---|
| −56°602 | 3885.2 mm | Meyers and Van Dusen (1933) |
| −56°24 | 3876 mm | Kuenen and Robson (1902) |

**Constants of state.** — Gaseous State.

*Weight of the normal litre*

| | |
|---|---|
| 1.976938 g<br>Lp = 1.963331 + 0.013606 p (p = atm.) | Moles and Toral (1936) |
| 1.976935 g<br>Lp = 1.963340 + 0.013595 p | „<br>Moles and Escribano (1938) |

*Deviation from Avogadro's law:* $A_o^I = 1.00706$ GUYE and BATUECAS (1923).

*Coefficient of expansion:* $(12° \rightarrow 48°) = 3725.10^{-6}$ COPPOCK and WHYTLAW GRAY (1934).

*Dielectric constant:* VAN ITTERBEEK and SPAEPEN (1946); VAN ITTERBEEK and DE CLIPPELEIR (1946—47).

Liquid State. *Specific volume at various temperatures and pressures:* JENKINS (1921).

*Surface tension*

| | t° | $\gamma$ | t° | $\gamma$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|---|
| L. | −52.2 | 16.54 | −11.3 | 6.81 | 10 | 2.94 | QUINN (1927) |
| | −42.7 | 13.88 | − 6 | 5.79 | 15 | 2.09 | „ |
| | −32.3 | 11.25 | 0 | 4.62 | 20 | 1.37 | „ |
| | −21.7 | 9.05 | 5 | 3.75 | 25 | 0.59 | „ |

**Heat constants**

*Specific heat*

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|---|
| C. | −257.64 | 0.0138 | −211.90 | 0.1659 | −148.58 | 0.2372 | GIAUQUE and EGAN |
| | −252.01 | 0.03225 | −206.92 | 0.1751 | −142.98 | 0.2429 | „ (1937) |
| | −249.91 | 0.04070 | −201.94 | 0.1828 | −137.42 | 0.2472 | „ |
| | −245.44 | 0.06082 | −196.69 | 0.1902 | −132.02 | 0.2517 | „ |
| | −243.24 | 0.06974 | −191.22 | 0.1978 | −126.68 | 0.2561 | „ |
| | −240.37 | 0.08078 | −185.71 | 0.2041 | −121.49 | 0.2602 | „ |
| | −237.17 | 0.09234 | −180.45 | 0.2088 | −116.44 | 0.2645 | „ |
| | −233.73 | 0.1046 | −175.23 | 0.2141 | −111.16 | 0.2689 | „ |
| | −229.97 | 0.1180 | −170.00 | 0.2198 | −105.54 | 0.2743 | „ |
| | −225.54 | 0.1316 | −164.60 | 0.2248 | − 99.80 | 0.2800 | „ |
| | −221.05 | 0.1437 | −159.25 | 0.2288 | − 88.58 | 0.2913 | „ |
| | −216.99 | 0.1537 | −153.92 | 0.2334 | − 83.38 | 0.2966 | „ |
| | −212.30 | 0.1652 | | | | | „ |
| C. | −253.76 | 0.0245 | −238.46 | 0.0886 | −186.76 | 0.2089 | EUCKEN (1916) |
| | −251.16 | 0.0329 | −235.36 | 0.0995 | −184.76 | 0.2114 | „ |
| | −249.71 | 0.0402 | −231.86 | 0.1154 | −77.86 | 0.2964 | „ |
| | −247.76 | 0.0468 | −228.96 | 0.1241 | −74.26 | 0.2991 | „ |
| | −246.76 | 0.0539 | −193.01 | 0.2011 | −73.56 | 0.3023 | „ |
| | −243.86 | 0.0648 | −191.16 | 0.2023 | −72.66 | 0.3036 | „ |
| | −241.36 | 0.0745 | −190.41 | 0.2043 | | | „ |

*Specific heat* (continued)

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|---|
| C. | −193.16 | 0.2000 | −143.16 | 0.2523 | −93.16 | 0.2841 | Eucken and Hauck |
| | −183.16 | 0.2136 | −133.16 | 0.2591 | −83.16 | 0.2902 | „ (1928) |
| | −173.16 | 0.2239 | −123.16 | 0.2659 | −73.16 | 0.3000 | „ |
| | −163.16 | 0.2329 | −113.16 | 0.2716 | −63.16 | 0.3114 | „ |
| | −153.16 | 0.2432 | −103.16 | 0.2784 | | | „ |
| L. | −53.16 | 0.4307 | −23.16 | 0.4727 | 6.84 | 0.5898 | Eucken and Hauck |
| | −43.16 | 0.4454 | −13.16 | 0.4886 | 16.84 | 0.7068 | „ (1928) |
| | −33.16 | 0.4614 | − 3.16 | 0.5295 | | | „ |

The curves drawn according to the values given by Giauque and Egan (1937) and by Eucken and Hauck (1928) are regular, but they do not agree absolutely, probably owing to a difference in the temperature scale.

*Heat of vaporisation*

| t° | cal 15°/g | t° | cal 15° g | |
|---|---|---|---|---|
| −50 | 79.9 | −10 | 60.9 | Jenkin and Pye (1914) |
| −45 | 77.8 | − 5 | 57.7 | „ |
| −40 | 75.7 | 0 | 54.1 | „ |
| −35 | 73.6 | 5 | 50.3 | „ |
| −30 | 71.3 | 10 | 46.2 | „ |
| −25 | 69.0 | 15 | 41.9 | „ |
| −20 | 66.5 | 20 | 36.55 | „ |
| −15 | 63.8 | | | „ |

# F. ANHYDRIDES

## ACETIC ANHYDRIDE $(CH_3CO)_2O$

### Constants

*Saturated vapour pressure*

| t° | p mm | | t° | pmm | |
|---|---|---|---|---|---|
| 37.2 | 7.5 | KAHLBAUM (1885) | 47.0 | 17.5 | KAHLBAUM (1885) |
| 39.9 | 10 | „ | 49.2 | 20 | „ |
| 42.6 | 12.5 | „ | 50.8 | 22.5 | „ |
| 44.9 | 15 | „ | | | |

*Boiling point:* 140°0 B.E. (1930)

*Freezing point:* −73°0 TIMMERMANS

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.10526 | B.E. (1930) | 25 | 1.0749 | LEWIS (1940) |
| 15 | 1.08712 | „ | 30 | 1.0690 | „ |
| 30 | 1.06911 | „ | 35 | 1.0629 | „ |
| | | | 40 | 1.0567 | „ |
| 15 | 1.0870 | LEWIS (1940) | 45 | 1.0505 | „ |
| 20 | 1.0810 | „ | 50 | 1.0443 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 971 | B.E. (1930) |
| 30 | 783 | „ |

*Surface tension*

| t° | $\gamma$ | t° | $\gamma$ | |
|---|---|---|---|---|
| 15 | 33.14 | 35 | 30.76 | LEWIS (1940) |
| 20 | 32.56 | 40 | 30.05 | „ |
| 25 | 31.90 | 45 | 29.57 | „ |
| 30 | 31.24 | 50 | 29.00 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.38971 | 1.39001 | 1.39229 | 1.39620 | 1.39717 | 1.40028 | 1.40118 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00040 | 39 | 41 | 41 | 40 | 42 | — | |

## PROPIONIC ANHYDRIDE $(C_2H_5CO)_2O$

**Constants**

*Saturated vapour pressure:* KAHLBAUM (1885)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 55.6 | 7.5 | 62.3 | 12.5 | 67.8 | 17.5 | 72.8 | 22.5 |
| 59.1 | 10 | 65.1 | 15 | 70.4 | 20 | | |

*Boiling point:* 167° KAHLBAUM (1885)

*Freezing point:* −45° TIMMERMANS (passim)

## *n*-CAPROIC ANHYDRIDE $(n\text{-}C_5H_{11}CO)_2O$

**Constants:** SIMON (1929)

*Freezing point:* −40°5

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.93630 | SIMON (1929) |
| 15 | 0.92397 | „ |
| 30 | 0.91155 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 3238 | SIMON (1929) |
| 30 | 2313 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42883 | 1.42912 | 1.43146 | 1.43156 | 1.43588 | 1.43694 | 1.44029 | 1.44163 |
| 25 | 1.42530 | 1.42556 | 1.42796 | 1.42806 | 1.43219 | 1.43332 | 1.43668 | 1.43791 |
| $\frac{dn}{dt}$ | 0.00035 | 36 | 35 | 35 | 37 | 36 | 36 | 37 |

## G. FATTY ACIDS

Generally, the acids are prepared by saponification of the nitriles or of the amides, or by decarboxylation of the corresponding substituted malonic acids.

### FORMIC ACID $H.CO_2H$

Formic acid is subjected to fractional distillation and fusion until constancy of the melting point and of the critical solution point in benzene for several consecutive fractions. MORTON (1919) obtained the anhydrous acid by distillation under reduced pressure in the presence of $P_2O_5$.

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Saturated vapour pressure*

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| L. | −5.23 | 8.12 | 39.89 | 85.18 | 110.62 | 1017.6 | COOLIDGE (1930) |
| | 0.00 | 11.16 | 49.93 | 130.1 | | | ,, |
| | +8.25 | 17.94 | 59.98 | 192.7 | C. −5.07 | 4.98 | ,, |
| | 12.57 | 22.72 | 70.04 | 280.6 | 0.00 | 8.22 | ,, |
| | 20.00 | 33.55 | 79.93 | 395.6 | +8.25 | 17.94 | ,, |
| | 29.96 | 54.36 | 100.68 | 762.5 | | | ,, |
| | 17.5 | 29.1 | 59.7 | 187.8 | | | KONOWALOW (188 |
| | 40.5 | 85.5 | 70.1 | 280.2 | | | ,, |
| | 21.9 | 34.3 | 52.9 | 141.8 | 82.3 | 424.6 | SCHMIDT (1891) |
| | 25.2 | 40.9 | 54.5 | 150.5 | 83.6 | 448.1 | ,, |
| | 35.0 | 65.0 | 57.5 | 171.5 | 84.1 | 452.0 | ,, |
| | 37.3 | 72.6 | 59.1 | 182.0 | 85.9 | 479.5 | ,, |
| | 41.8 | 88.6 | 62.8 | 211.5 | 87.5 | 506.1 | ,, |
| | 42.3 | 90.6 | 64.1 | 221.4 | 90.0 | 544.5 | ,, |
| | 45.8 | 105.9 | 66.7 | 244.6 | 93.6 | 614.8 | ,, |
| | 47.1 | 111.9 | 67.7 | 254.6 | 94.1 | 624.3 | ,, |
| | 49.3 | 121.0 | 74.2 | 319.7 | 96.2 | 668.6 | ,, |
| | 52.0 | 135.9 | 80.1 | 393.9 | 98.5 | 718.1 | ,, |
| | 50 | 127.2 | 60 | 191.2 | 75 | 335.6 | LANDOLT (1868) |
| | 55 | 156.5 | 65 | 232.1 | | | ,, |
| | 10 | 19.88 | — | — | — | — | COOLIDGE (1928) |

*Boiling point*

| | |
|---|---|
| 100°502 | Josefowicz (1938) |
| 100°70 | $\frac{dt}{dp}$ *(10 mm):* 0°40 B.E. (1930) |
| 100°75 | „ 0°40 Lecat |
| 100°8 | Alpert and Elving (1949) |

*Freezing point*

| | | | |
|---|---|---|---|
| 8°51 | Faucon (1910) | 8°40 | Pleskov (1946) |
| 8°50 | Joukovsky (1934) | 8°40 | B.E. (1930) |
| 8°50 | Deffet (1935) | 8°4 | Bateman and Hughes (1937) |
| 8°5 | Kendall (1914) | 8°39 | Ewins (1914) |
| 8°40 | Wrewski and Glagolewa (1928) | 8°30 | Stout and Fisher (1941) |
| 8°40 | Lange (1940) | 8°3 | Udovenko and Ayrapetova (1947) |

*Melting curve:* Deffet (1935)

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 8.50 | 1 | | 17.50 | 752 | |
| 12.50 | 335 | | 20.00 | 964 | |
| 15.00 | 548 | | | | |

*Critical solution point:* in $C_6H_6$ 74°15 B.E. (1930)

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 1.22647 | B.E. (1930) | 18 | 1.2224 | Schlesinger and Colman |
| 25 | 1.21405 | „ | 25 | 1.2142 | „ (1916) |
| 30 | 1.20775 | „ | 15 | 1.22627 | Perkin (1884–85) |
| 40 | 1.19538 | „ | 25 | 1.21384 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 7.59 | 2385 | Thorpe and Rodger | 64.20 | 838 | Thorpe and Rodger |
| 15.96 | 1951 | „ (1894) | 72.05 | 754 | „ (1894) |
| 24.16 | 1635 | „ | 80.22 | 681 | „ |
| 32.86 | 1379 | „ | 88.19 | 619 | „ |
| 40.36 | 1208 | „ | 97.23 | 558 | „ |
| 48.03 | 1064 | „ | 15 | 1966 | B.E. (1930) |
| 56.30 | 937 | „ | 30 | 1443 | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 38.13 | B.E. (1930) |
| 20 | 37.58 | ,, |
| 30 | 36.48 | ,, |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.37095 | 1.37137 | 1.37348 | 1.37747 | 1.37847 | 1.38137 |
| $\frac{dn}{dt}$ | 0.00038 | 38 | 38 | 38 | 38 | 39 |

*Magnetic rotatory power:* 20°8 0.7990 PERKIN (1884–85)

**Heat constants**

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −258.05 | 0.0104 | −179.28 | 0.1730 | −52.79 | 0.2779 | STOUT and FISHER |
| −255.73 | 0.0146 | −172.31 | 0.1818 | −45.55 | 0.2857 | (1941) (M.W. 46.026) |
| −253.39 | 0.0203 | −165.38 | 0.1900 | −38.26 | 0.2892 | ,, |
| −250.72 | 0.02683 | −158.27 | 0.1977 | −31.21 | 0.2940 | ,, |
| −247.85 | 0.03346 | −151.47 | 0.2047 | −24.32 | 0.2976 | ,, |
| −244.82 | 0.04145 | −144.59 | 0.2108 | −17.53 | 0.3029 | ,, |
| −241.67 | 0.05014 | −137.42 | 0.2177 | −10.98 | 0.3079 | ,, |
| −238.37 | 0.05953 | −131.11 | 0.2227 | − 4.54 | 0.3129 | ,, |
| −234.79 | 0.06944 | −124.11 | 0.2275 | + 1.82 | 0.3311 | ,, |
| −230.51 | 0.07974 | −117.45 | 0.2333 | L. 2.18 | 0.5082 | ,, |
| −225.71 | 0.09045 | −109.61 | 0.2394 | 6.58 | 0.5104 | ,, |
| −220.46 | 0.1023 | −102.47 | 0.2440 | 11.06 | 0.5117 | ,, |
| −215.02 | 0.1132 | − 95.36 | 0.2490 | 16.22 | 0.5132 | ,, |
| −209.94 | 0.1228 | − 88.16 | 0.2540 | 17.66 | 0.5134 | ,, |
| −204.54 | 0.1328 | − 80.98 | 0.2581 | 21.80 | 0.5141 | ,, |
| −198.78 | 0.1432 | − 73.80 | 0.2629 | 26.69 | 0.5145 | ,, |
| −192.63 | 0.1536 | − 66.89 | 0.2679 | | | ,, |
| −186.22 | 0.1634 | − 60.03 | 0.2731 | | | ,, |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 25° | 103.3 cal 15°/g | STOUT and FISHER (1941) |
| *Heat of melting* | | 65.87 ,, | ,, |
| | | 66.05 ,, | LANGE (1940) |

## ACETIC ACID $CH_3.CO_2H$

Acetic acid is distilled under reduced pressure in the presence of $P_2O_5$. It is then subjected to fractional distillation and fusion until constancy of melting point for successive fractions.

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 321.6 | 43400 | 0.3506 | Young (1910) |

*Density of the liquid and saturated vapour*

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 20 | 1.0491 | 0.0000764 | 180 | 0.8555 | 0.01370 |
| 30 | 1.0392 | 0.0001264 | 190 | 0.8413 | 0.01681 |
| 40 | 1.0284 | 0.0002012 | 200 | 0.8265 | 0.02052 |
| 50 | 1.0175 | 0.0003100 | 210 | 0.8109 | 0.02488 |
| 60 | 1.0060 | 0.0004621 | 220 | 0.7941 | 0.03021 |
| 70 | 0.9948 | 0.000673 | 230 | 0.7764 | 0.03626 |
| 80 | 0.9835 | 0.000959 | 240 | 0.7571 | 0.04327 |
| 90 | 0.9718 | 0.001338 | 250 | 0.7364 | 0.05163 |
| 100 | 0.9599 | 0.001833 | 260 | 0.7136 | 0.06165 |
| 110 | 0.9483 | 0.002468 | 270 | 0.6900 | 0.07365 |
| 120 | 0.9362 | 0.003271 | 280 | 0.6629 | 0.0883 |
| 130 | 0.9235 | 0.004275 | 290 | 0.6334 | 0.1073 |
| 140 | 0.9091 | 0.005515 | 300 | 0.5950 | 0.1331 |
| 150 | 0.8963 | 0.00703 | 310 | 0.5423 | 0.1718 |
| 160 | 0.8829 | 0.00887 | 320 | 0.4615 | — |
| 170 | 0.8694 | 0.01084 | 321.6 | 0.3506 | 0.3506 |

*Rectilinear diameter:* $0.5355 - 0.0005366\ t° - 0.0000001191\ t°^2$ Young (1910)

*Saturated vapour pressure*

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| C. | −5.68 | 1.3 | 7.20 | 4.05 | 13.96 | 7.30 | Ramsay and Young |
| | −0.60 | 1.95 | 8.40 | 4.25 | 14.85 | 8.00 | ,, (1885) |
| | +1.85 | 2.35 | 8.72 | 4.60 | 15.15 | 8.40 | ,, |
| | 2.86 | 2.80 | 9.16 | 4.70 | 15.80 | 8.85 | ,, |
| | 5.32 | 3.30 | 10.40 | 5.30 | 16.09 | 8.95 | ,, |
| | 6.30 | 3.70 | 11.39 | 5.75 | 16.20 | 9.10 | ,, |
| | 6.41 | 3.75 | 11.70 | 6.15 | 16.32 | 9.15 | ,, |
| | 6.68 | 3.85 | 12.60 | 6.65 | 16.41 | 9.45 | ,, |
| | 7.09 | 4.00 | | | | | ,, |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| L. 0 | 3.50 | 110 | 582.6 | 230 | 10402 | Young (1910); Ramsay |
| 10 | 6.34 | 130 | 1040 | 240 | 12501 | and Young (1885) |
| 20 | 11.80 | 140 | 1381 | 250 | 14866 | ,, |
| 30 | 19.90 | 150 | 1875 | 260 | 17579 | ,, |
| 40 | 34.00 | 160 | 2409 | 270 | 20651 | ,, |
| 50 | 56.20 | 170 | 3058 | 280 | 24123 | ,, |
| 60 | 88.30 | 180 | 3833 | 300 | 32043 | ,, |
| 70 | 137.10 | 190 | 4733 | 310 | 36943 | ,, |
| 80 | 202.1 | 200 | 5833 | 320 | 42553 | ,, |
| 90 | 292.8 | 210 | 7125 | 321.6 | 43400 | ,, |
| 100 | 416.5 | 220 | 8638 | | | ,, |
| 25 | 15.43 | Hovorka and Dreisbach (1934) | | | | |
| 49.99 | 55.4 | Zawidzki (1900) | | | | |
| 69.94 | 136.5 | ,, | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 118°1 | $\frac{dt}{dp}$ *(10 mm):* 0°42 Lecat | 118°5 | Beckman and Liesche (1914) |
| | | 118°5 | Young (1910) |
| 118°2 | ,, 0°42 B.E. (1930) | 118°7 | Mündel (1913) |
| 118°1 | Alpert and Elving (1949) | 118°7 | Kahlbaum and Schroeter (1898) |

*Freezing point*

| | | | |
|---|---|---|---|
| 16°55 | B.E. (1930) and Deffet (1935) | 16°62 | De Forcrand (1903) |
| 16°5965 | De Visser (1891–1893) (hydrogen therm.) | 16°63 | Wrewsky, Miscenko and Muromzew (1928) |
| 16°6713 | ,, (therm. in hart glas) | 16°63 | Hall and Voge (1933) |
| 16°6 | Udovenko and Ayrapetova (1947) | 16°63 | Hovorka and Dreisbach (1934) |
| | | 16°63 | Pool, Harwood and Ralston (1945) |
| 16°60 | Eichelberger and La Mer (1933) | | |
| 16°60 | Bousfield and Lowry (1911) | 16°635 | Hess and Haber (1937) |
| 16°60 | Mac Dougall (1936) | 16°70 | Faucon (1910 and 1909) |
| 16°60 | Louguinine and Dupont (1911) | 16°70 | Baud (1913) |
| 16°60 | Jones and Betts (1928) | 16°70 | Parks and Kelley (1925) |

*Melting curve*

| t° | p kg/cm² | | t° | p kg cm² | |
|---|---|---|---|---|---|
| 16.55 | 1 | DEFFET (1935) | 30.00 | 663 | DEFFET (1935) |
| 20.00 | 168 | „ | 35.00 | 907 | „ |
| 25.00 | 415 | „ | 36.00 | 957 | „ |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 1.0491 | YOUNG (1910) | 18 | 1.05148 | BOUSFIELD and LOWRY |
| 20 | 1.04926 | B.E. (1930) | 20 | 1.04922 | „ (1911) |
| 30 | 1.03802 | „ | 16.67 | L. 1.05315 | DE VISSER (1891–93) |
| 40 | 1.02679 | „ | 16.596 | S. 1.26585 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 30.86 | 1025 | THORPE and RODGER | 84.53 | 534 | THORPE and RODGER |
| 39.88 | 903.1 | „ (1894) | 93.97 | 484 | „ (1894) |
| 48.47 | 806 | „ | 102.89 | 445 | „ |
| 57.46 | 721 | „ | 112.57 | 406 | „ |
| 68.10 | 638 | „ | 15 | 1314 | B.E. (1930) |
| 76.66 | 580 | „ | 30 | 1040 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 27.95 | HENNAUT-ROLAND and LEK (1931) |
| 20 | 27.42 | „ |
| 30 | 26.34 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.37131 | 1.37165 | — | 1.37392 | 1.37767 | 1.37851 | 1.38152 | 1.38297 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00038 | 37 | — | 38 | 39 | 38 | 40 | — | „ |
| 25 | — | — | 1.3698 | — | — | — | — | — | PUSCHIN and MATAVULJ (1932) |

*Dielectric constant*

| t° | η | | t° | η | |
|---|---|---|---|---|---|
| 20 | 6.170 | Le Fevre (1938) | 60 | 6.512 | Le Fevre (1938) |
| 25 | 6.195 | „ | 70 | 6.631 | „ |
| 40 | 6.309 | „ | 80 | 6.800 | „ |
| 50 | 6.401 | „ | | | |

*Magnetic rotatory power*

| t° | λ 589.3 | λ 546 | λ 436 | |
|---|---|---|---|---|
| 15.2 | 0.6675 | 0.7838 | 1.2836 | Schwers (1912) |
| 32.0 | 0.6568 | 0.7712 | 1.2625 | „ |

**Heat constants**

*Specific heat:* Parks and Kelley (1925)

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|
| C. | −185.7 | 0.187 | −177.6 | 0.197 | −75.4 | 0.266 |
| | −184.0 | 0.189 | −177.0 | 0.197 | −74.2 | 0.268 |
| | −182.7 | 0.190 | −173.1 | 0.200 | −40.6 | 0.288 |
| | −182.4 | 0.192 | −119.6 | 0.239 | −34.2 | 0.296 |
| | −178.4 | 0.195 | − 78.5 | 0.262 | −17.6 | 0.311 |
| L. | 19.5 | 0.488 | | | | |
| | 21.6 | 0.491 | | | | |

| | | |
|---|---|---|
| *Heat of melting* | 45.91 cal 15°/g | Meyer (1910) |

## PROPIONIC ACID $C_2H_5.CO_2H$

The commercial product, purified by fractional distillation, shows the same constants as the sample obtained by synthesis from pure propionitrile.

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Critical temperature:* 337°6 Schmidt (1891)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 79.4 | 74.4 | 95.2 | 148.1 | 108.4 | 249.6 | KAHLBAUM and WIRKNER (1897) |
| 80.0 | 76.5 | 95.6 | 151.0 | 110.8 | 273.5 | ,, |
| 80.3 | 77.7 | 98.9 | 173.6 | 113.1 | 297.9 | ,, |
| 83.5 | 90.4 | 99.5 | 176.7 | 115.6 | 326.2 | ,, |
| 85.8 | 99.5 | 100.8 | 196.8 | 117.6 | 350.2 | ,, |
| 86.0 | 100.5 | 102.3 | 200.4 | 119.4 | 373.9 | ,, |
| 91.5 | 126.3 | 105.4 | 226.6 | 119.5 | 375.1 | ,, |
| | | | | | | ,, |
| 46.2 | 13.2 | 59.3 | 26.8 | 71.6 | 49.7 | KAHLBAUM and SCHROETER (1893–94) |
| 47.2 | 14.0 | 60.2 | 27.9 | 72.4 | 51.9 | ,, *(Dynamic method)* |
| 48.9 | 15.2 | 61.2 | 29.7 | 73.2 | 54.0 | ,, |
| 50.2 | 16.5 | 62.6 | 31.9 | 74.0 | 55.8 | ,, |
| 51.2 | 17.7 | 63.6 | 33.6 | 74.9 | 58.1 | ,, |
| 52.4 | 18.6 | 64.9 | 35.6 | 76.2 | 61.8 | ,, |
| 53.5 | 19.8 | 65.8 | 37.2 | 77.0 | 64.3 | ,, |
| 54.9 | 21.4 | 67.0 | 39.5 | 77.8 | 66.6 | ,, |
| 55.9 | 22.5 | 68.0 | 41.3 | 78.8 | 70.3 | ,, |
| 56.7 | 23.5 | 69.0 | 43.7 | 79.5 | 72.4 | ,, |
| 57.7 | 24.7 | 69.8 | 45.6 | | | ,, |
| 58.5 | 25.7 | 70.7 | 47.6 | | | ,, |
| 27.6 | 3.3 | 35.3 | 6.1 | 40.2 | 9.0 | KAHLBAUM and SCHROETER (1893–94) |
| 30.8 | 4.3 | 36.4 | 6.6 | 42.1 | 9.9 | ,, *(Static method)* |
| 31.5 | 4.5 | 37.0 | 7.0 | 45.2 | 12.3 | ,, |
| 33.5 | 5.2 | 38.3 | 7.7 | 46.2 | 13.2 | ,, |
| 35.2 | 6.1 | 40.3 | 8.7 | 46.5 | 13.4 | ,, |
| 39.7 | 8.37 | 65.2 | 35.87 | 113.7 | 303.44 | RICHARDSON (1886) |
| 46.7 | 13.20 | 77.7 | 66.27 | 120.3 | 388.80 | ,, |
| 49.6 | 15.84 | 83.2 | 86.45 | 135.7 | 650.00 | ,, |

*Boiling point*

| | |
|---|---|
| 141°22 | EYKMAN (1919) |
| 141°3 | $\frac{dt}{dp}$ *(10 mm)*: 0°43 LECAT |
| 141°35 | ,, B.E. (1930) |

*Freezing point*

| | |
|---|---|
| −20°8 | B.E. (1930) and DEFFET (1935) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| −20.8 | 1 | | −5.0 | 775 | |
| −15.0 | 260 | | 0 | 1033 | |
| −10.0 | 517 | | | | |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.01503 | B.E. (1930) | 14.85 | 0.9988 | EYKMAN (1895–1919) |
| 15 | 0.99874 | „ | 15.15 | 0.9987 | „ |
| 30 | 0.98260 | „ | 18.7 | 0.99483 | JAHN and MÖLLER (1894) |
| | | | 20 | 0.9930 | SCHJÄNBERG (1935) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 30 | 956 | DUNSTAN (1915) | 15 | 1175 | B.E. (1930) |
| 40 | 841 | „ | 30 | 958 | „ |
| 60 | 668 | „ | 25 | 1020 | DUNSTAN, THOLE and BENSON (1914) |
| 80 | 544 | „ | | | |
| 90 | 495 | „ | | | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 27.21 | B.E. (1930) and HENNAUT-ROLAND and LEK (1931) |
| 20 | 26.70 | „ |
| 30 | 25.71 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.38630 | 1.38658 | — | 1.38879 | 1.39267 | 1.39355 | 1.39655 | 1.39752 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00038 | 38 | — | 38 | 40 | 40 | 42 | 42 | ,, |
| 20 | — | 1.38453 | — | — | — | 1.39127 | — | 1.39497 | SCHJÄNBERG (1935) |
| 25 | — | — | 1.3848 | — | — | — | — | — | BROUGHTON (1934) |

*Magnetic rotatory power:* 20°3 0.8369 PERKIN (1885)

**Heat constants**

| | | |
|---|---|---|
| *Heat of combustion* | 18°5 → 20°, ($c_v$) 4931.5 cal 15°/g | SCHJÄNBERG (1935) |

## *n*-BUTYRIC ACID $n$-$C_3H_7.CO_2H$

**Constants:** B.E. (1932). — **Polyphasic equilibria**

*Critical temperature:* 354°74 BROWN (1903)

*Saturated vapour pressure*: SCHMIDT (1891)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 107.3 | 99.0 | 118.3 | 156.8 | 129.5 | 243.0 |
| 108.4 | 103.0 | 118.9 | 160.9 | 131.5 | 261.5 |
| 109.8 | 110.1 | 122.8 | 189.2 | 134.5 | 291.6 |
| 110.2 | 111.3 | 123.2 | 190.2 | 136.9 | 318.5 |
| 114.1 | 131.1 | | | | |
| 115.6 | 139.1 | | | | |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 164°0 | $\frac{dt}{dp}$ *(10 mm):* 0°45 LECAT | −5°50 | B.E. (1932) and DEFFET (1935) |
| 164°05 | „ 0°45 B.E. (1932) | −5°55 | DE MOL (1925) |

The values of the boiling and freezing points of DREISBACH and MARTIN (1949) do not agree with those of the other authors.

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| −5.50 | 1 | 10.15 | 837 |
| 0.00 | 290 | 13.00 | 986 |
| 5.15 | 567 | | |

*Critical solution point:* in $H_2O$: −4°1 B.E. (1932)

**Constants of State.**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 24.7 | 0.9534 | FALK (1909) | 10 | 0.9682 | GARTENMEISTER (1890) |
| 32.4 | 0.9457 | „ | 20 | 0.9580 | „ |
| 40.8 | 0.9373 | „ | 30 | 0.9479 | „ |
| 48.0 | 0.9302 | „ | 40 | 0.9377 | „ |
| 58.8 | 0.9198 | „ | 50 | 0.9274 | „ |
| 67.4 | 0.9113 | „ | 0 | 0.97762 | B.E. (1932) |
| 20 | 0.95767 | DREISBACH and MARTIN | 15 | 0.96286 | „ |
| 25 | 0.95273 | „ (1949) | 30 | 0.94797 | „ |
| 14 | 0.9638 | EYKMAN (1919) | 0 | 0.97773 | DE MOL (1925) |
| 25 | 0.9528 | MERRY and TURNER (1914) | 15 | 0.96305 | „ |
| 25 | 0.9528 | BILTZ, FISCHER and WÜNNENBERG (1930) | | | |

| *Viscosity* | | | *Surface tension* | | |
|---|---|---|---|---|---|
| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
| 15 | 1814 | | 15 | 27.32 | |
| 30 | 1385 | | 20 | 26.74 | |
| | | | 30 | 25.57 | |

*Refractive index*

| t° | He r. | H | D | He y. | He g. | He | He v. | H | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.39775 | 1.39803 | — | 1.40030 | 1.40425 | 1.40510 | 1.40814 | 1.40963 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00042 | 42 | — | 43 | 44 | 44 | 45 | 45 | „ |
| 20.3 | — | 1.39582 | 1.39777 | — | — | 1.40271 | — | 1.40685 | Falk (1909) |
| 23.0 | — | 1.39459 | 1.39662 | — | — | 1.40157 | — | 1.40567 | „ |
| 31.1 | — | 1.39161 | 1.39364 | — | — | 1.39850 | — | 1.40256 | „ |
| 32.7 | — | 1.39093 | 1.39291 | — | — | 1.39779 | — | — | „ |
| $\frac{dn}{dt}$ | — | 0.0003985 | 395 | — | — | 3985 | — | 404 | „ |
| 20 | — | — | 1.39796 | — | — | — | — | — | Dreisbach and |
| 25 | — | — | 1.39581 | — | — | — | — | — | Martin (1949 |
| $\frac{dn}{dt}$ | — | — | 0.00043 | — | — | — | — | — | „ |
| 18 | — | — | 1.3990 | — | — | — | — | — | Whitby (1926) |
| 70 | — | 1.3756 | 1.3775 | — | — | 1.3822 | — | 1.3859 | Waterman and Bertram (1927 |

## *Iso*-BUTYRIC ACID $(CH_3)_2CH.CO_2H$

**Constants:** B.E. (1934). — **Polyphasic equilibria**

*Critical temperature:* 336°25 Brown (1906)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 68.2 | 22.4 | 84.6 | 51.4 | 96.2 | 88.7 | 105.8 | 133.9 | Kahlbaum and Wirkner (1897) |
| 73.8 | 30.3 | 87.4 | 58.9 | 99.1 | 100.7 | 110.8 | 165.3 | „ |
| 79.6 | 40.7 | 92.6 | 74.9 | 99.3 | 102.0 | 115.4 | 197.5 | „ |
| 84.5 | 51.3 | 93.0 | 76.5 | 100.5 | 106.9 | 119.4 | 231.1 | „ |
| 58.4 | 12.2 | 66.1 | 19.2 | 75.0 | 30.9 | 82.5 | 45.1 | Kahlbaum and Schroeter (1893) |
| 59.0 | 12.7 | 67.5 | 20.9 | 76.5 | 33.4 | 83.2 | 47.0 | „ |
| 59.6 | 13.2 | 68.6 | 22.1 | 77.9 | 36.0 | 84.4 | 50.0 | „ |
| 61.2 | 14.6 | 69.8 | 23.6 | 79.0 | 38.0 | 85.6 | 52.7 | „ |
| 62.7 | 15.8 | 71.0 | 25.2 | 79.6 | 39.0 | 86.3 | 55.0 | „ |
| 62.9 | 16.0 | 71.8 | 26.2 | 80.3 | 40.3 | 87.4 | 58.3 | „ |
| 64.1 | 17.2 | 72.8 | 27.4 | 80.8 | 41.7 | 87.9 | 59.2 | „ |
| 64.8 | 17.8 | | | | | | | „ |
| 67.20 | 20.90 | 104.80 | 127.90 | 124.3 | 283.66 | 131.20 | 358.84 | Richardson (1886) |
| 89.8 | 66.369 | 110.30 | 160.00 | 126.80 | 308.57 | 143.80 | 552.24 | „ |
| 96.3 | 89.09 | | | | | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 119.7 | 243.7 | 134.7 | 414.2 | 143.0 | 504.9 | SCHMIDT (1891) |
| 121.3 | 257.8 | 135.5 | 428.0 | 145.7 | 599.9 | „ |
| 123.5 | 279.9 | 136.4 | 441.2 | 146.2 | 612.2 | „ |
| 125.6 | 303.1 | 138.2 | 471.1 | | | „ |
| 126.1 | 306.9 | 140.0 | 498.0 | | | „ |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 154°6 | $\frac{dt}{dp}$ *(10 mm):* 0°46 LECAT | −46°1 | B.E. (1934) |
| 154°70 | „ 0°46 B.E. (1934) | | |

*Critical solution point:* in $H_2O$: 26°20 B.E. (1934)

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −45.0 | 1.01462 | TIMMERMANS (1912) | 0 | 0.96815 | B.E. (1934) |
| −35.3 | 1.00430 | „ | 15 | 0.95296 | „ |
| −30.6 | 1.99930 | „ | 30 | 0.93782 | „ |
| −22.95 | 0.99136 | „ | | | |
| −13.1 | 0.98141 | „ | | | |
| − 6.2 | 0.97450 | „ | | | |
| 0 | 0.96820 | „ | | | |
| +17.5 | 0.95060 | „ | | | |

| *Viscosity* | | | *Surface tension* | | |
|---|---|---|---|---|---|
| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
| 15 | 1440 | B.E. (1934) | 15 | 25.55 | B.E. (1934) |
| 30 | 1126 | „ | 20 | 25.13 | „ |
| 25 | 1220 | THOLE (1914) | 30 | 24.22 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.39287 | 1.39332 | 1.39646 | 1.39933 | 1.40038 | 1.40351 |
| $\frac{dn}{dt}$ | 0.00039 | 40 | 40 | 40 | 42 | 42 |

## *n*-VALERIC ACID $n\text{-}C_4H_9.CO_2H$

**Constants:** B.E. (1932)

*Critical temperature*: 378°87 BROWN (1906)

*Boiling point:*

| | |
|---|---|
| 186°2 | EYKMAN (1919) |
| 186°34 | $\frac{dt}{dp}$ *(10 mm):* 0°51 HANUS (1925) |
| 186°35 | „ 0°47 B.E. (1932) |
| 186°35 | „ 0°46 LECAT (passim) |

*Freezing point:* −34°5

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| −34.5 | 1 | −20.0 | 903 |
| −30.0 | 320 | −19.0 | 968 |
| −25.0 | 601 | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.95744 | B.E. (1932) | 25 | 0.9348 | BILTZ, FISCHER and WÜNNENBERG (1930) |
| 15 | 0.94374 | „ | | | |
| 30 | 0.93017 | „ | 0 | 0.95730 | LIEVENS (1924) |
| 18.15 | 0.9411 | EYKMAN (1906–19) | 15 | 0.94354 | „ |
| 19.1 | 0.9397 | „ | 0 | 0.95741 | HANUS (1925) |
| | | | 15 | 0.94372 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2359 | B.E. (1932) |
| 30 | 1774 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 27.83 | B.E. (1932) |
| 20 | 27.36 | „ |
| 30 | 26.35 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.40781 | 1.40820 | 1.41049 | 1.41455 | 1.41555 | 1.41864 | 1.42006 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00041 | 42 | 42 | 43 | 44 | 45 | 45 | „ |

## *Iso*-VALERIC ACID or *iso*-PROPYLACETIC ACID $(CH_3)_2CH.CH_2.CO_2H$

**Constants:** B.E. (1932)

*Critical temperature:* 360°68 Brown (1906)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 88.2 | 22.891 | 93.82 | 31.087 | 142.25 | 253.443 | Richardson (1886) |
| 88.85 | 24.291 | 111.8 | 74.354 | 151.29 | 349.711 | „ |
| 89.35 | 23.99 | 128.8 | 155.873 | 157.20 | 434.53 | „ |
| 120.67 | 110.60 | 151.45 | 350.9 | 182.6 | 953.5 | Landolt (1893) |
| 139.70 | 235.2 | 161.4 | 500.0 | 188.8 | 1155.1 | „ |
| 142.80 | 261.4 | 172.0 | 695.9 | | | „ |

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 123.1 | 123.6 | 138.2 | 221.7 | 158.8 | 444.9 | Schmidt (1891) |
| 124.1 | 127.6 | 145.5 | 289.9 | 160.1 | 479.6 | „ (dynamic method) |
| 130.1 | 161.8 | 150.1 | 340.8 | 165.6 | 571.1 | „ |
| 136.8 | 209.4 | 157.2 | 432.8 | 168.4 | 624.6 | „ |
| 125.7 | 135.1 | 139.9 | 234.0 | 153.5 | 380.1 | „ (static method) |
| 136.1 | 204.1 | 144.8 | 276.4 | 166.1 | 572.3 | „ |

*Boiling point*

| | |
|---|---|
| 176°14 | Sudborough and Davies (1909) |
| 176°5 | $\frac{dt}{dp}$ *(10 mm):* 0°46 B.E. (1932) and Lecat |

*Freezing point*

| | |
|---|---|
| −29°3 | Timmermans |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.94462 | |
| 15 | 0.93080 | |
| 30 | 0.91708 | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2731 | |
| 30 | 1967 | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 25.78 | B.E. (1932) |
| 20 | 25.30 | ,, |
| 30 | 24.45 | ,, |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.40263 | 1.40300 | 1.40533 | 1.40929 | 1.41051 | 1.41347 | 1.41482 |
| $\frac{dn}{dt}$ | 0.00040 | 41 | 41 | 45 | 45 | 46 | 46 |

METHYLETHYLACETIC ACID $CH_3.CH(C_2H_5).CO_2H$ and
TRIMETHYLACETIC ACID $C(CH_3)_3.CO_2H$: Eykman (1919)

This work appears to have been done well, but comparative data are lacking.

## *n*-CAPROIC ACID $n\text{-}C_5H_{11}.CO_2H$

**Constants:** Simon (1929)

*Boiling point*

| | |
|---|---|
| 205°15 | Lecat |
| 205°35 | Simon (1929) |

*Freezing point*

| | |
|---|---|
| −3°6 | Garner, Madden and Rushbrooke (1926) |
| −3°9 | Simon (1929) |
| −3°95 | Deffet (1935) |
| −4°25 | Broughton (1934) |

*Melting curve:* Deffet (1935)

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|---|---|
| −3.95 | 1 | 10.00 | 760 | 13.50 | 942 |
| 0.00 | 218 | 11.00 | 813 | 14.50 | 996 |
| +5.00 | 487 | 12.50 | 890 | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.94428 | Simon (1929) | 25 | 0.9230 | Prideaux and Coleman (1936) |
| 15 | 0.93136 | „ | 80 | 0.8751 | Dorinson, Mc Corkle and Ralston (1942) |
| 30 | 0.91832 | „ | | | |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 3525 | Simon (1929) | 25 | 27.49 | Prideaux and Coleman (1936) |
| 30 | 2511 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41627 | 1.41653 | 1.41877 | 1.41878 | 1.42300 | 1.42395 | 1.42720 | 1.42836 | Simon (1929) |
| 25 | 1.41241 | 1.41272 | 1.41489 | 1.41494 | 1.41907 | 1.42015 | 1.42334 | 1.42454 | „ |
| $\frac{dn}{dt}$ | 0.00039 | 38 | 39 | 38 | 40 | 38 | 39 | 39 | „ |
| 25 | — | — | 1.4149 | — | — | — | — | — | Broughton (1934) |
| 20.0 | — | — | 1.4170 | — | — | — | — | — | Dorinson, Mc Corkle |
| 25.0 | — | — | 1.4150 | — | — | — | — | — | and Ralston (1942) |
| 30.0 | — | — | 1.4132 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00038 | — | — | — | — | — | „ (other temperatures see authors) |

## *Iso*-CAPROIC ACID $(CH_3)_2CH.(CH_2)_2.CO_2H$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 58.2 | 0.2 | 82.6 | 4.9 | 89.6 | 7.7 | 98.1 | 12.2 | Kahlbaum and Schroeter (1893) |
| 73.6 | 2.1 | 83.1 | 5.1 | 90.6 | 8.2 | 99.6 | 13.5 | „ |
| 74.4 | 2.4 | 83.7 | 5.4 | 91.7 | 8.8 | 99.9 | 13.8 | „ |
| 75.0 | 2.6 | 84.6 | 5.7 | 91.9 | 8.9 | 100.8 | 14.5 | „ |
| 76.6 | 3.1 | 84.9 | 5.8 | 95.9 | 11.0 | 101.3 | 15.0 | „ |
| 77.0 | 3.2 | 87.3 | 6.9 | 97.0 | 11.6 | 102.7 | 16.2 | „ |
| 81.8 | 4.6 | 88.5 | 7.2 | 97.5 | 11.9 | 104.6 | 17.8 | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 105.6 | 18.8 | 114.3 | 29.5 | 121.4 | 41.5 | 128.1 | 56.8 | KAHLBAUM and SCHROETER (1893) |
| 106.2 | 19.5 | 116.2 | 32.2 | 122.4 | 43.7 | 128.6 | 58.7 | „ |
| 107.9 | 21.1 | 116.7 | 34.1 | 123.0 | 45.1 | 129.3 | 61.1 | „ |
| 109.1 | 22.8 | 117.5 | 34.9 | 123.9 | 46.9 | 129.6 | 62.5 | „ |
| 110.2 | 23.8 | 118.7 | 37.3 | 125.2 | 50.1 | 130.0 | 62.7 | „ |
| 111.0 | 25.2 | 120.4 | 39.5 | 126.3 | 52.1 | 133.2 | 72.7 | „ |
| 111.8 | 26.2 | 121.1 | 40.9 | 127.3 | 54.9 | | | „ |
| 109.6 | 23.4 | 138.9 | 90.9 | 165.9 | 248.7 | 188.5 | 539.0 | KAHLBAUM and WIRKNER (1897) |
| 115.7 | 31.7 | 139.0 | 91.7 | 170.9 | 302.5 | 189.9 | 558.3 | „ |
| 117.6 | 35.1 | 141.2 | 99.3 | 174.6 | 341.4 | 192.0 | 599.7 | „ |
| 120.7 | 40.6 | 141.3 | 100.4 | 177.1 | 371.4 | 193.5 | 629.3 | „ |
| 125.4 | 50.4 | 147.2 | 126.6 | 179.6 | 403.3 | 195.4 | 665.6 | „ |
| 129.5 | 60.3 | 151.8 | 150.4 | 181.8 | 434.0 | 196.9 | 695.4 | „ |
| 132.6 | 70.9 | 153.7 | 162.8 | 184.3 | 471.2 | 199.0 | 742.2 | „ |
| 134.4 | 75.6 | 159.4 | 200.0 | 186.3 | 502.3 | 199.7 | 760.0 | „ |
| 135.8 | 80.3 | | | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 199°4 | HOMMELEN (1933) | 199°7 | KAHLBAUM and WIRKNER (1897) |
| 199°5 | LECAT | 199°7 | FRANKE (1895) |

*Freezing point:* −33° TIMMERMANS

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.9392 | HOMMELEN (1933) |
| 20 | 0.9225 | „ |
| 21.5 | 0.9209 | EYKMAN (1919) |

*Refractive index*

| t° | Hα | D | He y. | Hβ | Hγ | |
|---|---|---|---|---|---|---|
| 20 | 1.4122 | 1.4144 | 1.4144 | 1.4196 | 1.4238 | HOMMELEN (1933) |
| 21.5 | 1.41236 | — | — | 1.41962 | — | EYKMAN (1919) |
| 81.2 | 1.38873 | — | — | 1.39551 | — | „ |
| 70 | 1.3946 | 1.3967 | — | 1.4016 | 1.4055 | WATERMAN and BERTRAM (1927) |

ISOMERIC HEXANOIC ACIDS: $(C_2H_5).CH(CH_3).CH_2.CO_2H$; $(CH_3)_3C.CH_2.CO_2H$; $n\text{-}C_3H_7 > CH.CO_2H$; $(CH_3)_2CH > CH.CO_2H$; $(C_2H_5)_2CH.CO_2H$; $C_2H_5 > C(CH_3)_2 > CO_2H$:
*Boiling, melting points, density* and *refractive index*; HOMMELEN (1933).

## *n*-HEPTANOIC ACID or OENANTHIC ACID $n\text{-}C_6H_{13}.CO_2H$

BILTERYS (1935) prepared his acid by permanganic oxidation of pure freshly-distilled oenanthol.

**Constants:** BILTERYS (1935)

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 223°01 | $\frac{dt}{dp}$ *(10 mm):* 0°45 BILTERYS (1935) | −7°46<br>−7°5 | BILTERYS (1935)<br>GARNER, MADDEN and RUSHBROOKE (1926) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|---|---|
| −7.5 | 1 | 0.00 | 418 | 10.00 | 976 |
| −5.0 | 141 | 5.00 | 696 | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.93454 | BILTERYS (1935) | 30 | 0.90989 | BILTERYS (1935) |
| 15 | 0.92217 | „ | 80 | 0.8670 | DORINSON, MC CORKLE and RALSTON (1942) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 5046 | BILTERYS (1935) |
| 30 | 3413 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42208 | 1.42235 | — | 1.42455 | 1.42894 | 1.42999 | — | BILTERYS (1935) |
| $\frac{dn}{dt}$ | 0.00035 | 35 | — | 35 | 35 | 35 | — | „ |
| 20.0 | — | — | 1.4230 | — | — | — | — | DORINSON, MC CORKLE and RALSTON (1942) |
| 25.0 | — | — | 1.4209 | — | — | — | — | |
| 30.0 | — | — | 1.4192 | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00038 | — | — | — | — | „ |
| | | | | | | | | (other temperatures see authors) |
| 70 | — | 1.4008 | 1.4029 | — | — | 1.4079 | 1.4119 | WATERMAN and BERTRAM (1927) |

## *n*-CAPRYLIC ACID $n\text{-}C_7H_{15}.CO_2H$

**Constants:** DEFFET (1931)

*Saturated vapour pressure:* POOL and RALSTON (1942)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 87.5 | 1 | 109.1 | 4 | 134.6 | 16 | 165.3 | 64 |
| 97.9 | 2 | 121.3 | 8 | 140.2 | 32 | 183.3 | 128 |

*Boiling point:* 239°3 DEFFET (1931)

*Freezing point*

| | | | |
|---|---|---|---|
| 16°30 | HOERR and RALSTON (1944) | 16°3 | BROUGHTON (1934) |
| 16°30 | POOL and RALSTON (1942) | 16°3 | DEFFET (1931) |
| 16°3 | HOLDE and GENTNER (1925) | 16 51 | HOERR, SEDGWICK and RALSTON (1946) |

*Melting curve*

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 16.30 | 1 | DEFFET (1935) | 30.00 | 669 | DEFFET (1935) |
| 20.00 | 190 | | 35.00 | 922 | „ |
| 25.00 | 434 | „ | | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 0.90884 | DEFFET (1931) | 80 | 0.8615 | DORINSON, MC CORKLE and RALSTON (1942) |
| 30 | 0.90087 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 20 | 5828 | DEFFET (1931) |
| 30 | 4690 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 1.42519 | 1.42558 | — | 1.42793 | 1.43235 | 1.43338 | 1.43663 | 1.43785 | Deffet (1931) |
| $\frac{dn}{dt}$ | 0.00037 | 37 | — | 38 | 38 | 37 | 38 | — | |
| 20.0 | — | — | 1.4280 | — | — | — | — | — | ,, |
| 25.0 | — | — | 1.4260 | — | — | — | — | — | Dorinson, Mc Corkle and Ralston (1942) |
| 30.0 | — | — | 1.4243 | — | — | — | — | — | ,, |
| $\frac{dn}{dt}$ | — | — | 0.00037 | — | — | — | — | — | ,, |
| | | | | | | | | | (other temperatures see authors) |
| 70 | — | 1.4063 | 1.4085 | — | — | 1.4134 | — | 1.4176 | Waterman and Bertram (1927) |

## *n*-NONOIC ACID or PELARGONIC ACID $n$-$C_8H_{17}.CO_2H$

Deffet (1931), Garner and Ryder (1925), Gartenmeister (1890), Waterman and Bertram (1927), Pool and Ralston (1942), Hoerr and Ralston (1944) and Dorinson, Mc Corkle and Ralston (1942) found similar but not identical data; the choice is difficult.

## *n*-CAPRIC ACID $n$-$C_9H_{19}.CO_2H$

**Constants**

*Melting point*

| | | | |
|---|---|---|---|
| 31° | Holde and Gentner (1925) | 31°35 | Hoerr, Sedgwick and Ralston (1946) |
| 31°1 | Scheij (1899) | | |
| 31°24 | Hoerr and Ralston (1944) | 31°35 | Krafft (1882) |
| 31°3 | Kahlbaum and Schroeter (1893–94) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 35.05 | 0.8884 | Garner and Ryder (1925) | 40 | 0.8858 | Scheij (1899) |
| 50.17 | 0.8773 | ,, | 80 | 0.8531 | Dorinson, Mc Corkle and Ralston (1942) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 40 | — | 1.42855 | — | — | Scheij (1899) |
| 60.6 | — | 1.4201 | — | — | Holde and Gentner (1925) |
| 40.0 | — | 1.4288 | — | — | Dorinson, Mc Corkle and Ralston (1942) |
| 50.0 | — | 1.4248 | — | — | ,, |
| 70 | 1.4149 | 1.4170 | 1.4222 | 1.4263 | Waterman and Bertram (1927) |

## *n*-UNDECANOIC ACID $n\text{-}C_{10}H_{21}.CO_2H$

*Saturated vapour pressure* and *melting point;* Pool and Ralston (1942) and Hoerr and Ralston (1944); *density* and *refractive index;* Dorinson, Mc Corkle and Ralston (1942); *refractive index;* Waterman and Bertram (1927).

## *n*-LAURIC ACID $n\text{-}C_{11}H_{23}.CO_2H$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 43°92 | Hoerr and Ralston (1944) | 44° | Eykman (1919) |
| 43°92 | Hoerr, Sedgwick and Ralston (1946) | 44°1 | Loury and Stora (1949) |
| 44° | Holde and Gentner (1925) | 44°5 | Piper, Malkin and Austin (1926) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 45.10 | 0.8744 | Garner and Ryder (1925) | 70 | 0.8573 | Holde and Gentner (1925) |
| 50.25 | 0.8707 | „ | | | |
| 78.5 | 0.8495 | „ | 80 | 0.8477 | Dorinson, Mc Corkle and Ralston (1942) |
| | | | 82.1 | 0.8475 | Eykman (1893) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He bl. | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 78.5 | — | 1.41749 | — | — | — | 1.42474 | — | — | — | Eykman (189 |
| 82.1 | 1.41593 | 1.41624 | — | 1.41843 | 1.42262 | 1.42363 | 1.42468 | 1.42665 | 1.42787 | „ (191 |
| 45.0 | — | — | 1.4323 | — | — | — | — | — | — | Dorinson, |
| 50.0 | — | — | 1.4304 | — | — | — | — | — | — | Mc Corkle an |
| 55.0 | — | — | 1.4288 | — | — | — | — | — | — | Ralston (194 |
| 60.0 | — | — | 1.4267 | — | — | — | — | — | — | „ |
| 65.0 | — | — | 1.4250 | — | — | — | — | — | — | „ |
| 70.0 | — | — | 1.4230 | — | — | — | — | — | — | „ |
| 80.0 | — | — | 1.4191 | — | — | — | — | — | — | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 50 | 6877 | Bingham and Fornwalt | 120 | 1789 | Bingham and Fornwalt |
| 60 | 5367 | „ | 140 | 1350 | „ (1930) |
| 80 | 3510 | „ (1930) | 160 | 1041 | „ |
| 100 | 2457 | „ | | | |

## *n*-TRIDECANOIC ACID $n\text{-}C_{12}H_{25}.CO_2H$

*Melting point, specific heat* and *melting heat;* GARNER, MADDEN and RUSHBROOKE (1926); *density* and *refractive index;* DORINSON, MC CORKLE and RALSTON (1926).

## *n*-MYRISTIC ACID $n\text{-}C_{13}H_{27}.CO_2H$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 53°5 | KRAFFT (1879) | 53°8 | HEINTZ (1855) |
| 53°6 | SCHEIJ (1899) | 53°8 | KRAFFT (1880) |
| 53°7 | GARNER, MADDEN and RUSHBROOKE (1926) | 53°8 | JOGLEKAR and WATSON (1928) |
| 53°7 | HOLDE and GENTNER (1925) | 54°15 | HOERR and RALSTON (1944) and HOERR, SEDGWICK and RALSTON (1946) |
| 53°8 | STOHMAN, KLEBER and LANGBEIN (1889) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 70 | 0.8528 | DUNSTAN (1915) | 70 | 0.8533 | HOLDE and GENTNER (1925) |
| 90 | 0.8394 | „ | 80 | 0.8439 | DORINSON, MC CORKLE and RALSTON (1942) |
| 60 | 0.8584 | SCHEIJ (1899) | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 56.8 | 28.6 | HUNTEN and MAASS (1929) | 109.2 | 24.2 | HUNTEN and MAASS (1929) |
| 60.3 | 28.4 | „ | 119.2 | 23.6 | „ |
| 66.2 | 27.6 | „ | 129.2 | 22.7 | „ |
| 74.2 | 27.3 | „ | 138.3 | 22.0 | „ |
| 76.2 | 27.0 | „ | 149.3 | 21.3 | „ |
| 89.2 | 25.7 | „ | | | |

*Refractive index*

| t° | D | t° | D | |
|---|---|---|---|---|
| 55.0 | 1.4329 | 70.0 | 1.4273 | DORINSON, MC CORKLE and RALSTON (1942) |
| 60.0 | 1.4310 | 88.0 | 1.4236 | „ |
| 65.0 | 1.4291 | — | — | „ |
| 60 | 1.43075 | — | — | SCHEIJ (1899) |
| 70 | 1.4273 | — | — | HOLDE and GENTNER (1925) |

## *n*-PENTADECANOIC ACID $n\text{-}C_{14}H_{29}.CO_2H$

*Melting point, specific heat* and *heat of melting:* GARNER, MADDEN and RUSHBROOKE (1926); *melting point:* HOERR and RALSTON (1944) and *refractive index;* DORINSON, MC CORKLE and RALSTON (1942).

## *n*-PALMITIC ACID $n\text{-}C_{15}H_{31}.CO_2H$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 62°53 | FRANCIS and COLLINS (1936) | 62°618 | DE VISSER (1898) |
| 62°53 | FRANCIS, COLLINS and PIPER (1937) | 62°66 | SMITH (1931) |
| | | 62°67 | SMITH (1936) |
| 62°6 | SCHEIJ (1899) | 62°74 | GUY and SMITH (1939) |
| 62°6 | BROUGHTON (1934) | 62°82 | HOERR and RALSTON (1944) |
| 62°6 | VOLD, LEGGETT and MAC BAIN (1940) | | and HOERR, SEDGWICK and RALSTON (1946) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 70 | 0.8487 | DUNSTAN (1915) | 75.8 | 0.8463 | EYKMAN (1893–1919) |
| 90 | 0.8347 | „ | 79.8 | 0.8423 | „ |
| 80 | 0.8412 | SCHEIJ (1899) | 80 | 0.8414 | DORINSON, MC CORKLE and RALSTON (1942) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 60 | — | 1.4339 | — | — | PASCAL (1914) |
| 70 | — | 1.4304 | — | — | „ |
| 80 | — | 1.4269 | — | — | |
| 70 | 1.4281 | 1.4303 | 1.4358 | 1.4404 | WATERMAN and BERTRAM (1927) |
| 75.8 | 1.42719 | — | 1.43458 | — | EYKMAN (1893) |
| 80 | — | 1.42693 | — | — | SCHEIJ (1899) |

## *n*-MARGARIC ACID $n\text{-}C_{16}H_{33}.CO_2H$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 60°94 | HOERR, and RALSTON (1944) | 61°18 | SMITH (1936) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 90.6 | 0.8355 | HUNTEN and MAASS (1929) | 129.0 | 0.8092 | HUNTEN and MAASS (1929) |
| 100.7 | 0.8282 | „ | 135.7 | 0.8039 | „ |
| 110.2 | 0.8213 | „ | 146.5 | 0.7961 | „ |

*Viscosity*

| t° | $\eta \cdot 10^4$ | |
|---|---|---|
| 67.6 | 926 | HUNTEN and MAASS (1929) |
| 76.0 | 747 | „ |
| 107.1 | 403 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 66.9 | 27.9 | HUNTEN and MAASS (1929) | 126.1 | 23.8 | HUNTEN and MAASS (1929) |
| 90.8 | 26.0 | „ | 141.0 | 22.5 | „ |
| 112.0 | 24.4 | „ | | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 70 | 1.4296 | 1.4319 | 1.4371 | 1.4416 | WATERMAN and BERTRAM (1927) |

## *n*-STEARIC ACID $n\text{-}C_{17}H_{35}.CO_2H$

### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 69°2 | Scheij (1899) | 69°4 | Holde and Gentner (1925) |
| 69°2 | Heintz (1855) | 69°41 | Smith (1931) |
| 69°3 | Fisher (1939) | 69°42 | Smith (1936) |
| 69·32 | Francis, Collins and Piper (1937) | 69·5 | Loury and Stora (1949) |
| 69·32 | Hoerr and Ralston (1944) | 69·60 | Hoerr, Sedgwick and Ralston (1946) |
| 69°32 | De Visser (1898) | | |
| 69·35 | Francis and Collins (1936) | 69°60 | Guy and Smith (1939) |
| 69·35 | Joglekar and Watson (1928) | 69·9 | Thiessen and Stüber (1938) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 80 | 0.8386 | Scheij (1899) | 80 | 0.8390 | Dorinson, Mc Corkle and Ralston (1942) |
| | | | 80.2 | 0.8398 | Eykman (1919) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He bl. | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 80.2 | 1.42744 | 1.42766 | — | 1.43000 | 1.43430 | 1.43534 | 1.43643 | 1.43848 | 1.43973 | Eykman (1919) |
| 80 | — | — | 1.4300 | — | — | — | — | — | — | Whitby (1926) |
| 80 | — | — | 1.43003 | — | — | — | — | — | — | Scheij (1899) |

## *n*-ARACHIDIC ACID $n\text{-}C_{19}H_{39}.CO_2H$

*Melting point* and *heat of melting:* Garner, Madden and Rushbrooke (1926).

# H. DIBASIC ACIDS

## ANHYDROUS OXALIC ACID $(CO_2H)_2$

Purified by fractional crystallization from $H_2O$ and dried *in vacuo* over $P_2O_5$ at 70° to 80°.

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 59.55 | 0.0108 | 79.82 | 0.0672 | 90.31 | 0.1645 | Noyes and Wobbe (1926) |
| 65.65 | 0.0183 | 80.50 | 0.0722 | 99.49 | 0.3412 | „ |
| 74.40 | 0.0426 | 86.17 | 0.1161 | 105.28 | 0.5374 | „ |
| 78.40 | 0.0588 | 86.90 | 0.1236 | | | „ |
| 18.5 | 0.00081 | 32.7 | 0.00306 | 47.0 | 0.007805 | Granovskaja (1947) |

## SUCCINIC ACID $CO_2H(CH_2)_2CO_2H$

### Constants

*Saturated vapour pressure*

| t° | p mm | |
|---|---|---|
| 18.5 | 0.002205 | Granovskaja |
| 32.7 | 0.008962 | „ (1947) |
| 47.0 | 0.03317 | „ |

*Melting point*

| | |
|---|---|
| 182°3 | Phelps and Hubbard (1907) |
| 182°7 | Viseur (1926) |
| 182°8 | Mac Neight and Smyth (1936) |

*Specific heat:* Parks and Huffman (1930)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −179.76 | 0.134 | −133.46 | 0.174 | −28.86 | 0.262 | + 1.44 | 0.295 |
| −172.26 | 0.141 | −118.46 | 0.187 | −13.16 | 0.277 | 10.26 | 0.296 |
| −160.46 | 0.152 | − 88.06 | 0.211 | − 7.26 | 0.289 | 16.64 | 0.303 |
| −147.66 | 0.162 | − 58.16 | 0.237 | − 0.76 | 0.344 | | |

| | | |
|---|---|---|
| *Heat of combustion* | 18°8, ($c_v$) 3026.1 cal 15°/g | Beckers (1931) |
| | 20°, ($c_v$) 3025 „ | Keffler (1934) |
| | 20°, ($c_v$) 3025.7 „ | Roth and Becker (1937) |

SATURATED DIBASIC ACIDS from $C_2$ to $C_{13}$: *Melting point:* Voerman (1903-04) and Serwy (1933); *melting point* and *heat of combustion:* Holleman, Van der Laan and Sluiter (1904), Hartman (1925), Verkade, Hartman and Coops Jr. (1926), Verkade, Coops and Hartman (1926) and Verkade and Hartman (1933); *melting point:* Morrison and Robertson (1949)

MALONIC ACID: *Saturated vapour pressure:* Granovskaja (1947).

SUBSTITUTED MALONIC ACIDS: *Heat of combustion:* Verkade and Coops (1933).

SUBSTITUTED SUCCINIC ACIDS: *Melting point* and *heat of combustion:* Verkade, Hartman and Coops (1924-26), Verkade and Hartman (1933), and Verkade, Coops and Hartman (1925–26)

GLUTARIC ACID and ADIPIC ACID: *Saturated vapour pressure:* Granovskaja (1947)

METHYL and DIMETHYLGLUTARIC ACIDS: *Rotatory power:* Fredga (1947)

## I. UNSATURATED ACIDS

Eykman (1919) has studied the density and the refractive index of the following acids:

| | |
|---|---|
| ACRYLIC ACID | $CH_2=CH.CO_2H$ (B.P.) 140°5 Lecat (passim) |
| DIMETHYLACRYLIC ACID | $(CH_3)_2C=CH.CO_2H$ |
| TIGLIC and ANGELIC ACIDS | $CH_3.CH=C(CH_3)CO_2H$ |
| TRIMETHYLACRYLIC ACID | $(CH_3)_2C=C(CH_3)CO_2H$ |
| PROPYL-ETHYLACRYLIC ACID | $(C_3H_7)CH=C(C_2H_5)CO_2H$ |
| CROTONIC ACID | $CH_3.CH=CH.CO_2H$ |
| ALLYL-ACETIC ACID | $CH_2=CH(CH_2)_2.CO_2H$ |
| HEPTENOIC ACID | $CH_2=CH(CH_2)_4.CO_2H$ |
| OCTENOIC ACID | $CH_3.CH=C(C_2H_5).CH(CH_3).CO_2H$ |
| UNDECENOIC ACID | $CH_2=CH(CH_2)_8.CO_2H$ |
| STEARENIC ACID | $CH_2=CH(CH_2)_{15}.CO_2H$ |
| ELAIDIC ACID | $CH_3(CH_2)_7.CH=CH(CH_2)_7.CO_2H$ |
| ERUCIC ACID | $CH_3(CH_2)_7.CH=CH(CH_2)_{11}.CO_2H$ |

### OLEIC ACID $CH_3.(CH_2)_7.CH=CH(CH_2)_7.CO_2H$

**Constants**

*Melting point:* 16° Bertram (1927)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.8939 | Keffler and Mac Lean | 30 | 0.8835 | Keffler and Mac Lean |
| 20 | 0.8905 | „ (1935) | 60 | 0.8634 | „ (1935) |
| 25 | 0.8870 | „ | 90 | 0.8429 | „ |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 20 | 3880 | KEFFLER and MAC LEAN | 45 | 1408 | KEFFLER and MAC LEAN |
| 25 | 2764 | „ (1935) | 60 | 941 | „ (1935) |
| 30 | 2301 | „ | 80 | 485 | „ |
| 35 | 1946 | „ | | | |

*Refractive index*

| | | |
|---|---|---|
| $n_D^{20°}$ | 1.45823 | BERTRAM (1927) |
| $n_D^{70°}$ | 1.44179 | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 20°, ($c_v$) 9438.2 cal. 15°/g | KEFFLER (1935) |

RICINOLEIC ACID $CH_3(CH_2)_5.CH(OH).CH_2.CH{=}CH(CH_2)_7CO_2H$

**Constants:** ANDRE and VERNIER (1932)

*Density* *Viscosity*

| t° | d | t° | d | t° | $\eta$ | t° | $\eta$ |
|---|---|---|---|---|---|---|---|
| 23.6 | 0.9439 | 76.0 | 0.9090 | 23.6 | 3.848 | 76.2 | 0.2480 |
| 36.9 | 0.9352 | 99.7 | 0.8927 | 37.4 | 1.633 | 100 | 0.1106 |
| 51.7 | 0.9254 | | | 51.7 | 0.7321 | | |

*Refractive index*

| t° | $n_D$ | t° | $n_D$ |
|---|---|---|---|
| 15 | 1.4732 | 36 | 1.46585 |
| 20 | 1.47145 | 45 | 1.4627 |
| 26 | 1.46935 | 53 | 1.4598 |

*Rotatory power* $[\alpha]_D^{23°}$: +7.28

MALEIC ACID *(cis)* $CO_2H.CH{=}CH.CO_2H$ FUMARIC ACID *(trans)*

*Specific heat:* Parks and Huffman (1930)

## J. ESTERS

**Method of purification**

By shaking with calcined $Na_2CO_3$; drying over $Na_2CO_3$ and, in order to remove the alcohol, distillating over $P_2O_5$, with which the esters form a gel, followed by fractional distillation.

### METHYL FORMATE $H.CO_2CH_3$

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Critcal constants*

| t° cr | p cr. mm | d cr. | |
|---|---|---|---|
| 214.0 | 45030 | 0.3489 | Young (1910) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1.00319 | 0.0007 | 90 | 0.8634 | 0.01350 | 180 | 0.6521 | 0.09434 | Young (1910) |
| 10 | 0.9889 | 0.0011 | 100 | 0.8452 | 0.01723 | 190 | 0.6148 | 0.1178 | „ |
| 20 | 0.9745 | 0.0016 | 110 | 0.8264 | 0.02160 | 200 | 0.5658 | 0.1524 | „ |
| 30 | 0.9598 | 0.002291 | 120 | 0.8070 | 0.02688 | 206 | 0.5241 | 0.1862 | „ |
| 40 | 0.9447 | 0.003236 | 130 | 0.7860 | 0.03344 | 210 | 0.4857 | 0.2188 | „ |
| 50 | 0.9294 | 0.004456 | 140 | 0.7638 | 0.04124 | 212 | 0.4549 | 0.2451 | „ |
| 60 | 0.9133 | 0.006039 | 150 | 0.7403 | 0.05063 | 213 | 0.4328 | 0.2681 | „ |
| 70 | 0.8968 | 0.008032 | 160 | 0.7136 | 0.06231 | 213.5 | 0.4157 | 0.2865 | „ |
| 80 | 0.8803 | 0.01049 | 170 | 0.6844 | 0.07634 | 214 | 0.3489 | 0.3489 | „ |

*Rectilinear diameter:* $0.5020 - 0.0007013\ t^\circ - 0.0000000665\ t^{\circ 2}$ Young (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −10 | 117.65 | 60 | 1991 | 130 | 11105 | 200 | 36685 | Young (1910) |
| 0 | 195.00 | 70 | 2673 | 140 | 13570 | 206 | 40085 | „ |
| 10 | 309.40 | 80 | 3508 | 150 | 16330 | 210 | 42510 | „ |
| 20 | 476.40 | 90 | 4524 | 160 | 19500 | 212 | 43755 | „ |
| 30 | 707.90 | 100 | 5774 | 170 | 23015 | 213 | 44410 | „ |
| 40 | 1029 | 110 | 7278 | 180 | 27040 | 213.5 | 44670 | „ |
| 50 | 1452 | 120 | 9016 | 190 | 31550 | 214 | 45030 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 31°50 | B.E. (1930) | 31°78 | THORPE and RODGER (1897) |
| 31°7 | LECAT (passim) | 31°80 | YOUNG and THOMAS (1893) |
| 31°77 | EYKMAN (1919) | 31°9 | YOUNG (1910) |

$\frac{dt}{dp}$ *(10 mm)*

| | | | |
|---|---|---|---|
| 0°34 | TIMMERMANS (1910) | 0°35 | B.E. (1930) and LECAT (passim) |
| 0°34 | EYKMAN (1919) | | |

*Freezing point:* — 99°0 TIMMERMANS

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.00317 | B.E. (1930) | 0 | 1.00320 | (sample A) YOUNG and THOMAS |
| 10 | 0.98864 | „ | 11.55 | 0.98674 | „ (1893) |
| 15 | 0.98149 | „ | 0 | 1.00318 | (sample B) „ |
| 20 | 0.97421 | „ | 12.65 | 0.98520 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.58 | 426.3 | THORPE and RODGER | 25.52 | 329.8 | THORPE and RODGER |
| 6.39 | 399.9 | „ (1897) | 29.26 | 319.0 | „ (1897) |
| 10.88 | 381.0 | „ | | | |
| 15.64 | 362.6 | „ | 15 | 360 | B.E. (1930) |
| 20.15 | 346.7 | „ | 25 | 328 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.34426 | 1.34465 | 1.34648 | 1.34995 | 1.35073 | 1.35339 | 1.35420 |
| $\frac{dn}{dt}$ | 0.00043 | 43 | 44 | 44 | 44 | 44 | 44 |

## ETHYL FORMATE $H.CO_2C_2H_5$

**Constants:** B.E. (1932). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 235.3 | 35535 | 0.3232 | Young (1910) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.94802 | 0.0003 | 100 | 0.8112 | 0.01032 | 200 | 0.6066 | 0.08621 | Young (1910) |
| 10 | 0.9346 | 0.0005 | 110 | 0.7955 | 0.01312 | 210 | 0.5724 | 0.1073 | .. |
| 20 | 0.9226 | 0.0008 | 120 | 0.7796 | 0.01657 | 220 | 0.5290 | 0.1379 | .. |
| 30 | 0.9094 | 0.0012 | 130 | 0.7628 | 0.02073 | 225 | 0.5014 | 0.1587 | .. |
| 40 | 0.8963 | 0.0017 | 140 | 0.7448 | 0.02564 | 230 | 0.4635 | 0.1890 | „ |
| 50 | 0.8827 | 0.002438 | 150 | 0.7257 | 0.03164 | 233 | 0.4281 | 0.2198 | .. |
| 60 | 0.8689 | 0.003370 | 160 | 0.7058 | 0.03876 | 234 | 0.4117 | 0.2353 | .. |
| 70 | 0.8552 | 0.004570 | 170 | 0.6843 | 0.04739 | 235.3 | 0.3232 | 0.3232 | .. |
| 80 | 0.8409 | 0.006098 | 180 | 0.6610 | 0.05747 | | | | . |
| 90 | 0.8262 | 0.007994 | 190 | 0.6355 | 0.07018 | | | | .. |

*Rectilinear diameter:* $0.4741 - 0.0006251\ t^\circ - 0.0000000694\ t^{\circ 2}$ Young (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −20 | 22.49 | 50 | 649.4 | 130 | 5954 | 190 | 18052 | Young (1910) |
| −10 | 41.50 | 60 | 921.5 | 140 | 7360 | 200 | 21148 | .. |
| 0 | 72.44 | 80 | 1706 | 150 | 8954 | 210 | 24601 | .. |
| 10 | 120.35 | 90 | 2265 | 160 | 10847 | 220 | 28527 | .. |
| 20 | 192.55 | 100 | 2950 | 170 | 12963 | 230 | 32968 | .. |
| 30 | 297.50 | 110 | 3782 | 180 | 15358 | 235.3 | 35535 | .. |
| 40 | 446.7 | 120 | 4778 | | | | | .. |
| 29.6 | 291 | 38.2 | 419 | 44.9 | 541 | 53.1 | 730 | Schumann (1881) |
| 33.2 | 342 | 41.5 | 477 | 49.4 | 638 | 56.4 | 814 | .. |

*Boiling point*

| | | | |
|---|---|---|---|
| 54°15 | $\frac{dt}{dp}$ *(10 mm):* | 0°37 | B.E. (1932) |
| 54°15 | „ | 0°36 | Lecat |
| 54°2 | | | Perkin (1884–85) |
| 54°2 | | | Brown (1903) |
| 54°25 | | | Thorpe and Rodger (1897) |
| 54·3 | „ | 0°37 | Young and Thomas (1893) |

*Freezing point:* −79°4

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.94815 | B.E. (1932) | 0 | 0.94807 | (sample A) YOUNG and THOMAS |
| 15 | 0.92892 | „ | 12.15 | 0.93273 | „ „ (1893) |
| 30 | 0.90958 | „ | 0 | 0.94796 | (sample) B) „ |
| | | | 13.5 | 0.93108 | „ „ |
| 20 | 0.9226 | LOWRY (1914) | 15 | 0.92906 | PERKIN (1884) |
| | | | 25 | 0.91608 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.46 | 502.4 | THORPE and RODGER | 43.37 | 317.8 | THORPE and RODGER |
| 6.57 | 465.6 | „ (1897) | 48.62 | 303.1 | „ (1897) |
| 11.52 | 440.9 | „ | 52.03 | 294.2 | „ |
| 16.58 | 417.1 | „ | | | |
| 22.59 | 391.0 | „ | 15 | 419 | B.E. (1932) |
| 27.90 | 369.8 | „ | 30 | 358 | „ |
| 33.25 | 350.1 | „ | 25 | 379 | DUNSTAN, THOLE and |
| 38.09 | 334.4 | „ | | | BENSON (1914) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 24.37 | B.E. (1932) |
| 20 | 23.84 | „ |
| 30 | 22.38 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.36021 | 1.36047 | 1.36253 | 1.36610 | 1.36685 | 1.36907 | 1.37087 |
| $\frac{dn}{dt}$ | 0.00044 | 44 | 44 | 45 | 45 | 45 | 47 |

*Magnetic rotatory power:* 18°8 0.8023 PERKIN (1884)

*Heat of vaporisation.* The heats of vaporisation given by BROWN (1906) and by MARSHALL and RAMSAY (1896) are incompatible, as also for the following esters.

## *n*-PROPYL FORMATE $H.CO_2n\text{-}C_3H_7$

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 264.85 | 30460 | 0.3093 | Young (1910) |

*Densities of the liquid and saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.92868 | 0.0001 | 90 | 0.8214 | 0.004107 | 180 | 0.6873 | 0.03236 | Young (1910) |
| 10 | 0.9173 | 0.0001 | 100 | 0.8080 | 0.005432 | 190 | 0.6691 | 0.03891 | „ |
| 20 | 0.9058 | 0.0003 | 110 | 0.7947 | 0.007047 | 200 | 0.6487 | 0.04717 | „ |
| 30 | 0.8943 | 0.0006 | 120 | 0.7811 | 0.009033 | 210 | 0.6259 | 0.05698 | „ |
| 40 | 0.8827 | 0.0008 | 130 | 0.7670 | 0.01140 | 220 | 0.6024 | 0.06897 | „ |
| 50 | 0.8708 | 0.0011 | 140 | 0.7523 | 0.01422 | 230 | 0.5757 | 0.08403 | „ |
| 60 | 0.8588 | 0.0016 | 150 | 0.7369 | 0.01770 | 240 | 0.5438 | 0.1045 | „ |
| 70 | 0.8486 | 0.002227 | 160 | 0.7209 | 0.02179 | 250 | 0.5025 | 0.1340 | „ |
| 80 | 0.8341 | 0.003040 | 170 | 0.7045 | 0.02667 | 260 | 0.4404 | 0.1848 | „ |

*Rectilinear diameter:* $0.4647 - 0.0005748\ t° - 0.0000000459\ t°^2$ Young (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −10 | 11.40 | 70 | 523.9 | 140 | 3676 | 210 | 13575 | Young (1910) |
| 0 | 21.40 | 80 | 734.5 | 150 | 4558 | 220 | 15870 | „ |
| 10 | 37.85 | 90 | 1004 | 160 | 5605 | 230 | 18465 | „ |
| 20 | 63.9 | 100 | 1345 | 170 | 6797 | 240 | 21425 | „ |
| 30 | 104.1 | 110 | 1770 | 180 | 8177 | 250 | 24693 | „ |
| 40 | 163.6 | 120 | 2288 | 190 | 9734 | 260 | 28520 | „ |
| 50 | 249.4 | 130 | 2915 | 200 | 11560 | 264.85 | 30460 | „ |
| 60 | 364.9 | | | | | | | „ |

*Boiling point*

| | | |
|---|---|---|
| 80°85 | $\frac{dt}{dp}$ *(10 mm)*: 0°40 | LECAT |
| 80°89 | | THORPE and RODGER (1897) |
| 80°9 | „ 0°40 | YOUNG and THOMAS (1893) |
| 80°9 | | YOUNG (1910) |

*Freezing point:* −92°9 TIMMERMANS

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.92866 | (sample A) | 0 | 0.92870 | (sample B) YOUNG and THOMAS |
| 16.65 | 0.90950 | „ | 13.70 | 0.91305 | „ (1893) |
| | | | 13.5 | 0.91290 | EYKMAN (1919) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|
| 0.35 | 664.8 | 30.77 | 455.7 | 61.56 | 331.5 | THORPE and RODGER |
| 7.34 | 604.1 | 38.54 | 418.5 | 67.13 | 313.1 | „ (1897) |
| 15.54 | 545.8 | 45.73 | 387.6 | 74.99 | 292.8 | „ |
| 23.16 | 497.5 | 54.15 | 356.4 | 77.55 | 286.1 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He bl. | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 13.5 | 1.37828 | 1.37855 | 1.38050 | 1.38424 | 1.38514 | 1.38610 | 1.38789 | 1.38898 | EYKMAN (1919) |

The butyl and amyl formates have never been studied with sufficient accuracy.

| Constants | | *n*-HEXYL FORMATE $H.CO_2n\text{-}C_6H_{13}$ | | *n*-HEPTYL FORMATE $H.CO_2n\text{-}C_7H_{15}$ | | *n*-OCTYL FORMATE $H.CO_2n\text{-}C_8H_{17}$ | |
|---|---|---|---|---|---|---|---|
| | | Bilterys (1935) | | Bilterys (1935) | | Gisseleire (1935) | |
| *Boiling point:* | | 155°51 | | 178°12 | | 198°80 | |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°48 | | — | | 0°39 | |
| *Freezing point:* | | −62°65 | | −46°4 Timmermans | | −39°1 | |
| *Density:* | 0° | 0.89959 | | 0.89587 | | 0.89123 | |
| | 15° | 0.88590 | | 0.88277 | | 0.87859 | |
| | 30° | 0.87219 | | 0.86968 | | 0.86587 | |
| *Viscosity:* $\eta \cdot 10^5$ | 15° | 1115 | | 1366 | | 1750 | |
| | 30° | 879 | | 1063 | | 1318 | |
| *Surface tension:* | 15° | — | | — | | 28.92 | |
| | 20° | — | | — | | 28.30 | |
| | 30° | — | | — | | 27.05 | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.40638 | 0.00040 | 1.41252 | 0.00040 | 1.41813 | 0.00039 |
| | Hα | 1.40690 | 40 | 1.41289 | 40 | 1.41850 | 39 |
| | He y. | 1.40898 | 41 | 1.41505 | 40 | 1.42082 | 40 |
| | He g. | 1.41320 | 42 | 1.41924 | 41 | 1.42494 | 39 |
| | Hβ | 1.41413 | 42 | 1.42032 | 45 | 1.42599 | 39 |

*sec.* β-OCTYL FORMATE $H.CO_2C_8H_{17}$
*sec.* γ-NONYL FORMATE $H.CO_2C_9H_{19}$
} Pickard, Kenyon and Hunter (1923)

## METHYL ACETATE $CH_3.CO_2CH_3$

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 233.7 | 35212 | 0.3252 | Young (1910) |

*Densities of the liquid and saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.95932 | 0.0003 | 100 | 0.8221 | 0.009671 | 200 | 0.6100 | 0.08658 | Young (1910) |
| 10 | 0.9465 | 0.0005 | 110 | 0.8060 | 0.01239 | 210 | 0.5741 | 0.1091 | ,, |
| 20 | 0.9338 | 0.0007 | 120 | 0.7893 | 0.01570 | 220 | 0.5281 | 0.1416 | ,, |
| 30 | 0.9208 | 0.0010 | 130 | 0.7715 | 0.01970 | 227 | 0.4818 | 0.1776 | ,, |
| 40 | 0.9075 | 0.0015 | 140 | 0.7532 | 0.02454 | 230 | 0.4257 | 0.2028 | ,, |
| 50 | 0.8939 | 0.002212 | 150 | 0.7339 | 0.03026 | 232 | 0.4226 | 0.2288 | ,, |
| 60 | 0.8800 | 0.003076 | 160 | 0.7133 | 0.03731 | 233 | 0.3995 | 0.2525 | ,, |
| 70 | 0.8662 | 0.004193 | 170 | 0.6907 | 0.04598 | 233.7 | 0.3252 | 0 3252 | ,, |
| 80 | 0.8519 | 0.005618 | 180 | 0.6671 | 0.05682 | | | | ,, |
| 90 | 0.8374 | 0.007440 | 190 | 0.6410 | 0.06993 | | | | ,, |

*Rectilinear diameter:* $0.4799 - 0.0006280\ t° - 0.0000001467\ t°^2$ Young (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −20 | 19.05 | 50 | 588.15 | 130 | 5725 | 200 | 21085 | Young (1910) |
| −10 | 35.15 | 60 | 837.50 | 140 | 7100 | 210 | 24649 | ,, |
| 0 | 62.10 | 80 | 1585 | 150 | 8702 | 220 | 28705 | ,, |
| 10 | 104.85 | 90 | 2114 | 160 | 10566 | 230 | 33358 | ,, |
| 20 | 169.80 | 100 | 2778 | 170 | 12692 | 232 | 34334 | ,, |
| 30 | 265.75 | 110 | 3584 | 180 | 15118 | 233.7 | 35212 | ,, |
| 40 | 400.40 | 120 | 4556 | 190 | 17941 | | | ,, |

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 30 | 270 | Schmidt (1926) | 39.76 | 401.3 | Bredig and Bayer (1927) |
| 40 | 405 | ,, | 49.76 | 589.4 | ,, |
| 80 | 1588 | ,, | | | |

*Boiling point*

| | | |
|---|---|---|
| 56°95 | $\frac{dt}{dp}$ *(10 mm):* 0°37 | Lecat |
| 57°09 | | Thorpe and Rodger (1897) |
| 57°1 | $\frac{dt}{dp}$ *(10 mm):* 0°37 | Young and Thomas (1893) |
| 57°15 | | Young (1910) |
| 57°2 | | Chadwell (1926) |
| 57°25 | | Schmidt (1891) |
| 57°323 | ,, 0°375 | Wojciechowski and Smith (1937) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.95934 | (sample A) | 0 | 0.95929 | (sample B) YOUNG and THOMAS |
| 14.45 | 0.94097 | „ | 14.27 | 0.94110 | „ (1893) |
| 20 | 0.93347 | CHADWELL (1925) | | | |
| 25 | 0.92740 | „ (1926) | 25 | 0.9273 | WOJCIECHOWSKI and SMITH (1937) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|
| 0.34 | 476.2 | 22.75 | 370.6 | 46.06 | 294.3 | THORPE and RODGER |
| 6.31 | 443.6 | 28.38 | 349.2 | 50.34 | 282.9 | „ (1897) |
| 11.41 | 418.6 | 33.86 | 330.4 | 54.33 | 272.7 | „ |
| 16.71 | 393.8 | 40.45 | 310.0 | | | „ |
| 19.5 | 386 | 56.7 | 267 | 80.4 | 217 | TITANI (1927) |
| 20.3 | 382 | 60.3 | 258 | 110.2 | 167 | „ |
| 34.5 | 328 | 65.0 | 249 | 139.0 | 132 | „ |
| 46.1 | 294 | | | | | „ |

*Refractive index*

| λ | 2747 | 3025 | 3101 | 3195 | 3307 | 3491 | 3560 | 3975 | |
|---|---|---|---|---|---|---|---|---|---|
| 20° | 1.3985 | 1.3887 | 1.3866 | 1.3843 | 1.3819 | 1.3785 | 1.3773 | 1.3725 | EVANS and EVANS (1929) |
| λ | 4713 | 5016 | 5461 | 5876 | 5893 | 6678 | — | — | „ |
| 16°8 | 1.3685 | 1.3678 | 1.3663 | 1.3643 | 1.3639 | 1.3622 | — | — | „ |

## Heat constants

| | | |
|---|---|---|
| *Heat of vaporization* | (B.P). 97.0 cal 15° g | MARSHALL and RAMSAY (1896) |
| *Heat of combustion* | 18.5 → 20° ($c_v$) 5139.8 „ | SCHJÄNBERG (1934) |

## ETHYL ACETATE $CH_3.CO_2C_2H_5$

Water, ethyl alcohol and acetic acid may be detected down to a concentration of $4.10^{-3}$ % (Gillo, 1938). This author concludes that it is impossible to obtain a sample of very great purity owing to decomposition of the product, even when kept *in vacuo*, in sealed tubes and in the dark. Furthermore, this compound is very hygroscopic. It is impossible to attain more than the fourth degree of purity, that is: $\triangle t = 0°007$ (see Wojciechowski).

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 250.1 | 28878 | 0.3077 | Young (1910) |

*Densities of the liquid and saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.92436 | 0.0001 | 100 | 0.7972 | 0.006158 | 200 | 0.6210 | 0.05797 | |
| 10 | 0.9127 | 0.0002 | 110 | 0.7831 | 0.008006 | 210 | 0.5944 | 0.07128 | Young (1910) |
| 20 | 0.9005 | 0.0003 | 120 | 0.7683 | 0.01030 | 220 | 0.5648 | 0.08905 | ,, |
| 30 | 0.8885 | 0.0005 | 130 | 0.7533 | 0.01314 | 230 | 0.5281 | 0.1131 | ,, |
| 40 | 0.8762 | 0.0008 | 140 | 0.7378 | 0.01650 | 240 | 0.4778 | 0.1499 | ,, |
| 50 | 0.8636 | 0.0012 | 150 | 0.7210 | 0.02070 | 245 | 0.4401 | 0.1802 | ,, |
| 60 | 0.8508 | 0.0018 | 160 | 0.7033 | 0.02577 | 247 | 0.4195 | 0.1996 | ,, |
| 70 | 0.8376 | 0.002561 | 170 | 0.6848 | 0.03165 | 249 | 0.3839 | 0.2288 | ,, |
| 80 | 0.8245 | 0.003495 | 180 | 0.6653 | 0.03883 | 250.1 | 0.3077 | 0.3077 | ,, |
| 90 | 0.8112 | 0.004677 | 190 | 0.6441 | 0.04751 | | | | ,, |

*Rectilinear diameter:* $0.4624 - 0.0005992\ t° - 0.0000000764\ t°^2$ Young (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −20 | 6.55 | 60 | 415.4 | 140 | 4166 | 220 | 18255 | Young (1910) |
| −10 | 12.95 | 70 | 596.3 | 150 | 5168 | 230 | 21270 | ,, |
| 0 | 24.30 | 80 | 832.7 | 160 | 6369 | 240 | 24807 | ,, |
| 10 | 42.7 | 90 | 1130 | 170 | 7742 | 245 | 26740 | ,, |
| 20 | 72.8 | 100 | 1517 | 180 | 9318 | 247 | 27535 | ,, |
| 30 | 118.7 | 110 | 2001.5 | 190 | 11125 | 249 | 28370 | ,, |
| 40 | 186.2 | 120 | 2586 | 200 | 13200 | 250 | 28800 | ,, |
| 50 | 282.2 | 130 | 3298 | 210 | 15565 | 250.1 | 28877 | ,, |
| 49.99 | 280.5 | — | — | — | — | — | — | Zawidzki (1900) |

*Boiling point*

| | | |
|---|---|---|
| 77°1 | $\frac{dt}{dp}$ (10 mm): 0°41 | Lecat |
| 77°10 | | Tyrer (1912) |
| 77°112 | ,, 0°401 | Wojciechowski and Smith (1937) |
| 77°15 | | Tyrer (1914) |
| 77°15 | ,, 0°41 | Timmermans (1910–12) |
| 77°15 | ,, 0°41 | B.E. (1930) |
| 77°15 | ,, 0°40 | Young and Thomas (1893) and Young (1910) |
| 77°15 | | Chadwell (1926) |
| 77°15 | | Wade and Merriman (1912) |
| 77°15 | | Grimm and Patrick (1923) |
| 77°15 | | Gilman and Gross (1938) |
| 77°18 | | Thorpe and Rodger (1897) |
| 77°18 | | Young and Fortey (1903) |

*Freezing point:* −83°6 Timmermans, Van der Horst and Kamerlingh Onnes (1922)

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| +16.0 | 0.90550 | Timmermans (1912) | 0 | 0.92454 | Wade and Merriman |
| 0 | 0.92450 | ,, | 5 | 0.91865 | ,, (1912) |
| − 6.2 | 0.93199 | ,, | 10 | 0.91268 | ,, |
| −13.1 | 0.94024 | ,, | 15 | 0.90665 | ,, |
| −22.95 | 0.95187 | ,, | 20 | 0.90056 | ,, |
| −30.6 | 0.96088 | ,, | 25 | 0.89446 | ,, |
| −35.3 | 0.96646 | ,, | 30 | 0.88830 | ,, |
| −37.2 | 0.96859 | ,, | 35 | 0.88214 | ,, |
| −45.0 | 0.97778 | ,, | 40 | 0.87598 | ,, |
| −53.6 | 0.98772 | ,, | | | |
| −63.3 | 0.99897 | ,, | | | |
| −73.95 | 1.01128 | ,, | | | |
| −83.4 | 1.02220 | ,, | | | |
| 0 | 0.92453 | B.E. (1930) | 15 | 0.90545 | Perkin (1885) |
| 15 | 0.90657 | ,, | 25 | 0.89450 | ,, |
| 30 | 0.88851 | ,, | 0 | 0.92446 | Young and Fortey (1903) |
| 0 | 0.92434 | (samp. B) Young and Thomas (1893) | 25 | 0.89451 | Chadwell (1926) |
| | | | 25 | 0.89468 | Wojciechowski and Smith (1937) |
| 19.9 | 0.90070 | ,, ,, | | | |
| 0 | 0.92438 | (samp. A) ,, | 25 | 0.8947 | Peacock (1915) |
| 18.15 | 0.90286 | ,, ,, | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.25 | 576.3 | THORPE and RODGER | 51.15 | 322.4 | THORPE and RODGER |
| 8.90 | 514.4 | „ (1897) | 60.17 | 296.0 | „ (1897) |
| 14.46 | 479.5 | „ | 68.43 | 274.2 | „ |
| 21.38 | 441.8 | „ | 74.60 | 259.4 | „ |
| 28.12 | 409.6 | „ | 15 | 473 | B.E. (1930) |
| 36.54 | 373.8 | „ | 30 | 400 | „ |
| 44.12 | 345.5 | „ | 25 | 424.4 | CHADWELL (1926) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 24.36 | B.E. (1930) and HENNAUT-ROLAND and LEK (1931) |
| 20 | 23.75 | „ |
| 30 | 22.55 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.37281 | 1.37306 | — | 1.37510 | 1.37868 | 1.37962 | 1.38240 | 1.38342 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00048 | 48 | — | 49 | 49 | 49 | 51 | 51 | „ |
| 20 | — | — | 1.37243 | — | — | — | — | — | FISCHER and ZERBE (1923) |
| 25.2 | — | — | 1.37012 | — | — | — | — | — | ZAWIDZKI (1900) |

**Heat constants**

*Specific heat:* PARKS, HUFFMAN and BARMORE (1933)

| | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|
| C. | −180.96 | 0.199 | −164.66 | 0.219 | −127.86 | 0.257 |
| | −176.66 | 0.205 | −158.96 | 0.225 | −121.26 | 0.263 |
| | −176.06 | 0.206 | −147.96 | 0.237 | −117.16 | 0.269 |
| | −170.86 | 0.213 | −142.16 | 0.243 | −113.26 | 0.275 |
| | −169.16 | 0.214 | −137.06 | 0.248 | −105.86 | 0.285 |
| L. | −77.46 | 0.435 | − 28.66 | 0.438 | 15.54 | 0.456 |
| | −68.06 | 0.434 | − 14.86 | 0.443 | 20.44 | 0.459 |
| | −47.96 | 0.435 | + 1.74 | 0.450 | | |

| | | |
|---|---|---|
| *Heat of melting* | 28.43 cal 15°/g | PARKS, HUFFMAN and BARMORE (1933) |
| *Heat of combustion* | 18°5 → 20°, ($c_v$) 6070.5 „ | SCHJÄNBERG (1935) |

## *n*-PROPYL ACETATE $CH_3.CO_2n\text{-}C_3H_7$

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 276.2 | 25227 | 0.2957 | Young (1910) |

*Densities of the liquid and the saturated vapour:* Young (1910)

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.91016 | 0.00004 | 110 | 0.7830 | 0.004405 | 220 | 0.5987 | 0.05025 | Young (1910) |
| 10 | 0.8993 | 0.0001 | 120 | 0.7702 | 0.005760 | 230 | 0.5855 | 0.06154 | .. |
| 20 | 0.8884 | 0.0002 | 130 | 0.7571 | 0.007440 | 240 | 0.5586 | 0.07576 | .. |
| 30 | 0.8773 | 0.0003 | 140 | 0.7435 | 0.009497 | 250 | 0.5289 | 0.09390 | .. |
| 40 | 0.8663 | 0.0004 | 150 | 0.7297 | 0.01195 | 260 | 0.4908 | 0.1205 | .. |
| 50 | 0.8551 | 0.0006 | 160 | 0.7149 | 0.01489 | 266 | 0.4611 | 0.1445 | .. |
| 60 | 0.8435 | 0.0009 | 170 | 0.6997 | 0.01848 | 270 | 0.4333 | 0.1661 | .. |
| 70 | 0.8320 | 0.0012 | 180 | 0.6835 | 0.02268 | 273 | 0.4063 | 0.1912 | .. |
| 80 | 0.8201 | 0.0017 | 190 | 0.6667 | 0.02778 | 275 | 0.3769 | 0.2169 | .. |
| 90 | 0.8079 | 0.002457 | 200 | 0.6488 | 0.03390 | 276.2 | 0.2957 | 0.2957 | .. |
| 100 | 0.7957 | 0.003328 | 210 | 0.6301 | 0.04115 | | | | .. |

*Rectilinear diameter:* $0.4553 - 0.0005469\ t° - 0.0000001124\ t°^2$ Young (1910)

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 0 | 7.4 | 80 | 372.8 | 160 | 3441 | 240 | 14675 | Young (1910) |
| 10 | 13.9 | 90 | 524.8 | 170 | 4269 | 250 | 17090 | .. |
| 20 | 25.1 | 100 | 723.6 | 180 | 5189 | 260 | 19855 | .. |
| 30 | 42.7 | 110 | 976.0 | 190 | 6275 | 266 | 21685 | .. |
| 40 | 70.8 | 120 | 1293 | 200 | 7543 | 270 | 22980 | .. |
| 50 | 112.2 | 130 | 1685 | 210 | 8973 | 273 | 24060 | .. |
| 60 | 171.8 | 140 | 2171 | 220 | 10620 | 275 | 24750 | .. |
| 70 | 257.3 | 150 | 2747 | 230 | 12505 | 276.2 | 25227 | .. |

*Boiling point*

| | | |
|---|---|---|
| 101°545 | $\frac{dt}{dp}$ *(10 mm):* 0°430 | Wojciechowski and Smith (1937) |
| 101°55 | .. 0°43 | Young and Thomas (1893) and Young (1910) |
| 101°6 | | Lecat (passim) |

*Freezing point:* −95° Timmermans

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.91015 | (sample A) | 0 | 0.91017 | (sample B) YOUNG and THOMAS |
| 17.6 | 0.89082 | „ | 15.95 | 0.89269 | „ (1893) |
| | | | 25 | 0.88303 | WOJCIECHOWSKI and SMITH (1937) |

### *Iso*-PROPYL ACETATE $CH_3CO_2CH(CH_3)_2$

*Saturated vapour pressure:* HAGGERTY and WEILER (1929); *boiling point, density* and *viscosity:* SWARTS (1929); *refractive index* and *heat of combustion:* SCHJÄNBERG (1934).

### *n*-BUTYL ACETATE $CH_3.CO_2\,n\text{-}C_4H_9$

## Constants

*Boiling point*

| | | |
|---|---|---|
| 126°0 | $\frac{dt}{dp}$ *(10 mm):* 0°456 | LECAT |
| 126°103 | | WOJCIECHOWSKI and SMITH (1937) |
| 126°2 | | HANNOTTE (1926) |

*Freezing point:* −73°5 TIMMERMANS

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.9015 | GARTENMEISTER (1886) |
| 0 | 0.9015 | HANNOTTE (1926) |
| 25 | 0.87636 | WOJCIECHOWSKI and SMITH (1937) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.39464 | 1.39614 | 1.40146 | 1.40539 | HANNOTTE (1926) |

| | | |
|---|---|---|
| *Heat of combustion* | 18°5 → 20° ($c_v$) 7294.4 cal 15°/g | SCHJÄNBERG (1934) |

There are no reliable data for *n*-AMYLACETATE.

| | | *n*-HEXYL ACETATE $CH_3.CO_2n\text{-}C_6H_{13}$ | | *n*-HEPTYL ACETATE $CH_3.CO_2n\text{-}C_7H_{15}$ | |
|---|---|---|---|---|---|
| **Constants** | | GISSELEIRE (1935) | | BILTERYS (1935) | |
| *Boiling point:* | | 171°48<br>171°5 LECAT | | 192°45 | |
| $\frac{dt}{dp}$ *(10 mm):* | | 0°49 | | 0°52 | |
| *Freezing point:* | | −60°9 | | −50°2 | |
| *Density:* | 0° | 0.89147 | | 0.88811 | |
| | 15° | 0.87791 | | 0.87505 | |
| | 30° | 0.86427 | | 0.86199 | |
| *Viscosity* $\eta \cdot 10^5$: | 15° | 1254 | | 1598 | |
| | 30° | 968 | | 1216 | |
| *Surface tension:* | 15° | 26.99 | | — | |
| | 20° | 26.34 | | — | |
| | 30° | 25.14 | | — | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.40857 | 0.00041 | 1.41398 | 0.00041 |
| | Hα | 1.40905 | 41 | 1.41430 | 41 |
| | He y. | 1.41122 | 40 | 1.41653 | 41 |
| | He g. | 1.41508 | 40 | 1.42069 | 41 |
| | Hβ | 1.41626 | 40 | 1.42170 | 41 |

*n*-OCTYL ACETATE: $CH_3.CO_2n\text{-}C_8H_{17}$: *boiling point*, *density* and *refractive index*; EYKMAN (1919).

*sec.*-OCTYL and *sec.*-DECYL ACETATES: $CH_3.CO_2$ *sec.*-$C_8H_{17}$ and $CH_3.CO_2$ *sec.*-$C_{10}H_{21}$: PATTERSON and HOLMES (1936).

*n*-NONYL, DECYL, UNDECYL, DODECYL and TRIDECYL ACETATES: $CH_3CO_2$ *n*-$C_9H_{19}$, $C_{10}H_{21}$, $C_{11}H_{23}$, $C_{12}H_{25}$ and $C_{13}H_{27}$: *freezing point* and *polymorphism*; VAN BELLINGHEN (1938)

*sec*-BUTYL, HEXYL, HEPTYL, OCTYL, NONYL, DECYL, UNDECYL, TRIDECYL ACETATES: $CH_3.CO_2$ *sec.*-$C_4H_9$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_9H_{19}$, $C_{10}H_{21}$, $C_{11}H_{23}$, $C_{13}H_{27}$: PECKARD and KENYON (1914).

## *n*-CETYL ACETATE $CH_3.CO_2n\text{-}C_{16}H_{33}$

**Constants**

*Melting point:* 18°5 PERKIN (1884–'85)

*Density*

| t° | d | |
|---|---|---|
| 21 | 0.86234 | PERKIN (1884–85) |
| 25 | 0.85868 | „ |
| 33.9 | 0.8504 | EYKMAN (1919) |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He bl. | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 33.9 | 1.43333 | 1.43364 | 1.43591 | 1.44023 | 1.44129 | 1.44239 | 1.44444 | 1.44569 | EYKMAN (1919) |

*Specific magnetic rotatory power:* 20°7 1.0283 PERKIN (1884–85)

## VINYL ACETATE $CH_3.CO_2CH{=}CH_2$

*Density* and *surface tension;* GREEN, MARSDEN and CUTHBERTSON (1933).

## METHYL PROPIONATE $C_2H_5.CO_2CH_3$

**Constants. — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 257.4 | 30032 | 0.3124 | YOUNG (1910) |

*Densities of the liquid and saturated vapour:*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.93871 | 0.0001 | 110 | 0.7996 | 0.007446 | 210 | 0.6207 | 0.06390 | YOUNG (1910) |
| 10 | 0.9268 | 0.0002 | 120 | 0.7852 | 0.009569 | 220 | 0.5938 | 0.07812 | „ |
| 20 | 0.9151 | 0.0003 | 130 | 0.7705 | 0.01214 | 230 | 0.5635 | 0.09662 | „ |
| 30 | 0.9032 | 0.0005 | 140 | 0.7553 | 0.01529 | 240 | 0.5220 | 0.1236 | „ |
| 40 | 0.8912 | 0.0007 | 150 | 0.7390 | 0.01905 | 245 | 0.4976 | 0.1418 | „ |
| 50 | 0.8790 | 0.0011 | 160 | 0.7221 | 0.02356 | 250 | 0.4655 | 0.1675 | „ |
| 60 | 0.8665 | 0.0016 | 170 | 0.7045 | 0.02907 | 253 | 0.4401 | 0.1890 | „ |
| 70 | 0.8537 | 0.002331 | 180 | 0.6856 | 0.03552 | 255 | 0.4151 | 0.2118 | „ |
| 80 | 0.8408 | 0.003199 | 190 | 0.6657 | 0.04320 | 256 | 0.3892 | 0.2294 | „ |
| 90 | 0.8273 | 0.004301 | 200 | 0.6445 | 0.05236 | 257.4 | 0.3124 | 0.3124 | „ |
| 100 | 0.8137 | 0.005714 | | | | | | | „ |

*Rectilinear diameter:* $0.4696 - 0.0005921\ t° - 0.0000000729\ t°^2$ YOUNG (1910)

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −10 | 11.55 | 70 | 548.0 | 150 | 4830 | 230 | 20000 | Young (1910) |
| 0 | 21.9 | 80 | 771.0 | 160 | 5957 | 240 | 23325 | „ |
| 10 | 38.85 | 90 | 1045.0 | 170 | 7245 | 245 | 25115 | „ |
| 20 | 66.2 | 100 | 1406 | 180 | 8737 | 250 | 26997 | „ |
| 30 | 107.8 | 110 | 1854 | 190 | 10420 | 263 | 28205 | „ |
| 40 | 169.3 | 120 | 2406 | 200 | 12380 | 255 | 29055 | „ |
| 50 | 256.7 | 130 | 3071 | 210 | 14625 | 256 | 29445 | „ |
| 60 | 380.3 | 140 | 3888 | 220 | 17160 | 257.4 | 30032 | „ |

*Boiling point*

| | |
|---|---|
| 79°65 and 79°70 | Young and Thomas (1893) and Young (1910) |
| 79°70 | Thorpe and Rodger (1897) |
| 79°85 | Lecat |

*Freezing point:* −87°5 Timmermans

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.93871 | Young (1910) | 9.13 | 0.9278 | Prytz (1880) |
| 10 | 0.9268 | „ | 20 | 0.9148 | Schjänberg (1934) |
| 20 | 0.9151 | „ | 0 | 0.93874 | (sample A) Young and Thomas |
| 30 | 0.9032 | „ | 18.5 | 0.91700 | „ „ (1893) |
| | | | 0 | 0.93868 | (sample B) „ |
| | | | 16.4 | 0.91945 | „ „ |

*Viscosity:* Thorpe and Roger (1897)

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|---|---|
| 0.38 | 578.8 | 29.62 | 409.8 | 60.38 | 302.8 |
| 9.73 | 514.2 | 38.66 | 374.6 | 68.47 | 281.1 |
| 16.79 | 472.5 | 45.59 | 347.7 | 75.85 | 263.7 |
| 23.45 | 436.8 | 52.66 | 325.5 | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 9.7 | — | 1.3823 | — | — | Prytz (1880) |
| 20 | 1.37516 | 1.3775 | 1.38132 | 1.38482 | Schjänberg (1934) |

**Heat constant**

| | | |
|---|---|---|
| *Heat of combustion* | 18°5 → 20° ($c_v$) 6091.5 cal 15°/g | Schjänberg (1934) |

## ETHYL PROPIONATE $C_2H_5.CO_2C_2H_5$

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 272.9 | 25217 | 0.2965 | Young (1910) |

*Densities of the liquid and saturated vapour:*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.9124 | 0.00005 | 110 | 0.7823 | 0.004748 | 210 | 0.6243 | 0.04464 | Young (1910) |
| 10 | 0.9011 | 0.0001 | 120 | 0.7692 | 0.00620 | 220 | 0.6027 | 0.05435 | „ |
| 20 | 0.8901 | 0.0002 | 130 | 0.7548 | 0.00800 | 230 | 0.5784 | 0.06667 | „ |
| 30 | 0.8791 | 0.0003 | 140 | 0.7413 | 0.01024 | 240 | 0.5501 | 0.08230 | „ |
| 40 | 0.8672 | 0.0004 | 150 | 0.7267 | 0.01292 | 250 | 0.5181 | 0.1030 | „ |
| 50 | 0.8557 | 0.0006 | 160 | 0.7115 | 0.01615 | 260 | 0.4744 | 0.1337 | „ |
| 60 | 0.8440 | 0.0009 | 170 | 0.6958 | 0.02004 | 265 | 0.4459 | 0.1562 | „ |
| 70 | 0.8320 | 0.0013 | 180 | 0.6795 | 0.02469 | 268 | 0.4227 | 0.1751 | „ |
| 80 | 0.8201 | 0.0019 | 190 | 0.6625 | 0.03012 | 270 | 0.4018 | 0.1957 | „ |
| 90 | 0.8077 | 0.002674 | 200 | 0.6443 | 0.03676 | 272.9 | 0.2965 | 0.2965 | „ |
| 100 | 0.7951 | 0.003580 | | | | | | | „ |

*Rectilinear diameter:* $0.4564 - 0.0005644\ t° - 0.0000000784\ t°^2$ Young (1910)

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 0 | 8.30 | 80 | 403.6 | 160 | 3657 | 240 | 15425 | Young (1910) |
| 10 | 15.55 | 90 | 569.5 | 170 | 4505 | 250 | 17970 | „ |
| 20 | 27.75 | 100 | 785.0 | 180 | 5487 | 260 | 20825 | „ |
| 30 | 47.75 | 110 | 1048 | 190 | 6619 | 265 | 22400 | „ |
| 40 | 77.90 | 120 | 1386 | 200 | 7934 | 268 | 23415 | „ |
| 50 | 123.0 | 130 | 1801 | 210 | 9456 | 270 | 24105 | „ |
| 60 | 188.0 | 140 | 2316 | 220 | 11195 | 272.9 | 25217 | „ |
| 70 | 279.9 | 150 | 2920 | 230 | 13145 | | | „ |

*Boiling point:*

| | | | |
|---|---|---|---|
| 99°0 | $\frac{dt}{dp}$ *(10 mm)*: | 0°43 | Young and Thomas (1893) and Young (1910) |
| 99°10 | „ | 0°42 | B.E. (1930) and Lecat (passim) |
| 99°2 | | | Brown (1903) |

*Freezing point:* −73°85 Timmermans

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.91251 | B.E. (1930) | 0 | 0.91251 | Young and Fortey (1903) |
| 15 | 0.89574 | „ | 0 | 0.91245 | Timmermans (1910–12) |
| 30 | 0.87903 | „ | 0 | 0.91238 | Elsässer (1883) |
| 0 | 0.91238 | (sample A) Young and Thomas (1893) | | | |
| 16.65 | 0.89376 | „ | „ | | |
| 0 | 0.91242 | (sample B) | „ | | |
| 17.7 | 0.89259 | „ | „ | | |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^3$ | t° | $\gamma$ | |
|---|---|---|---|---|
| 15 | 564 | 15 | 24.83 | B.E. (1930) and Hennaut-Roland and Las (1931) |
| 30 | 473 | 20 | 24.27 | |
| | | 30 | 23.16 | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.38401 | 1.38442 | 1.38643 | 1.39017 | 1.39109 | 1.39402 | 1.39504 |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 46 | 47 | 48 | 48 | 48 |

## *n*-PROPYL PROPIONATE $C_2H_5.CO_2n\text{-}C_3H_7$

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 122°2 | Elsässer (1881) | 122°6 | Brown (1903) |
| 122°3 | Pawlewski (1882) | 123°0 | Lecat |
| 122°6 | Gartenmeister (1886) | | |

*Freezing point:* −75° Timmermans

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.90192 | Elsässer (1881–83) |
| 0 | 0.9022 | Gartenmeister (1886) |
| 20 | 0.8816 | „ (1890) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 20 | 686 | Gartenmeister (1890) |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He bl. | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 14.95 | 1.39377 | 1.39406 | 1.39606 | 1.39987 | 1.40080 | 1.40177 | 1.40359 | 1.40472 | Eykman (1919) |

| | | |
|---|---|---|
| *Heat of combustion* | 18°5 → 20° ($c_v$) 7291.4 cal 15°/g | Schjänberg (1934) |

*Iso*-BUTYLPROPIONATE: $C_2H_5.CO_2CH_2CH(CH_3)_2$: *boiling point* and *density:* Elsässer (1881–83); *boiling point, density* and *refractive index:* Munch (1926); *boiling point, density, refractive index* and *heat of combustion:* Schjänberg (1934–35); *boiling point* and *density:* Lecat.

The other butyl and amyl compounds have not been well studied.

| | | PROPIONATES | | | | | |
|---|---|---|---|---|---|---|---|
| | | *n*-HEXYL- $C_2H_5.CO_2n\text{-}C_6H_{13}$ | | *n*-HEPTYL- $C_2H_5.CO_2n\text{-}C_7H_{15}$ | | *n*-OCTYL- $C_2H_5.CO_2n\text{-}C_8H_{17}$ | |
| **Constants** | | Gisseleire (1935) | | Bilterys (1935) | | Gisseleire (1935) | |
| *Boiling point:* | | 190°0 | | 210°04 | | 227°93 | |
| $\frac{dt}{dp}$ *(10 mm):* | | — | | 0°53 | | 0°57 | |
| *Freezing point:* | | −57°5 | | −50°9 | | −41°6 | |
| *Density:* | 0° | 0.88761 | | 0.88492<br>0.8845 Gartenmeister (1886) | | 0.88271<br>0.8832 Gartenmeister (1886) | |
| | 15° | 0.87423 | | 0.87211 | | 0.87044 | |
| | 30° | 0.86093 | | 0.85937 | | 0.85812 | |
| *Viscosity* $\eta \cdot 10^5$: | 15° | 1377 | | 1718 | | 2128 | |
| | 30° | 1057 | | 1309 | | 1581 | |
| *Surface tension:* | 15° | 27.28 | | — | | 28.17 | |
| | 20° | 26.75 | | — | | 27.68 | |
| | 30° | 25.67 | | — | | 26.71 | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.41359 | 0.00040 | 1.41745 | 0.00038 | 1.42185 | 0.00037 |
| | Hα | 1.41389 | 40 | 1.41783 | 38 | 1.42209 | 36 |
| | He y. | 1.41621 | 40 | 1.42005 | 39 | — | — |
| | He g. | — | — | 1.42418 | 40 | 1.42871 | 37 |
| | Hβ | 1.42144 | 40 | 1.42523 | 40 | 1.42951 | 36 |

*sec*-BUTYL, AMYL, HEXYL, HEPTYL, OCTYL, UNDECYL PROPIONATES: $C_2H_5.CO_2$ *sec*.-$C_4H_9$, $C_5H_{11}$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_{11}H_{23}$: Pickard and Kenyon (1914) and Dunstan, Thole and Benson (1914).

## METHYL *n*-BUTYRATE $n\text{-}C_3H_7.CO_2CH_3$

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 281.3 | 26055 | 0.3002 | Young (1910) |

*Densities of the liquid and saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.92006 | 0.00004 | 110 | 0.7945 | 0.004374 | 220 | 0.6251 | 0.04831 | YOUNG (1910) |
| 10 | 0.9093 | 0.0001 | 120 | 0.7816 | 0.005708 | 230 | 0.6018 | 0.05848 | ,, |
| 20 | 0.8984 | 0.0001 | 130 | 0.7685 | 0.007353 | 240 | 0.5773 | 0.07143 | ,, |
| 30 | 0.8773 | 0.0002 | 140 | 0.7551 | 0.009294 | 250 | 0.5505 | 0.08696 | ,, |
| 40 | 0.8760 | 0.0003 | 150 | 0.7415 | 0.01168 | 260 | 0.5166 | 0.1091 | ,, |
| 50 | 0.8649 | 0.0005 | 160 | 0.7270 | 0.01459 | 270 | 0.4721 | 0.1416 | ,, |
| 60 | 0.8535 | 0.0008 | 170 | 0.7122 | 0.01807 | 275 | 0.4386 | 0.1691 | ,, |
| 70 | 0.8422 | 0.0012 | 180 | 0.6964 | 0.02215 | 278 | 0.4100 | 0.1948 | ,, |
| 80 | 0.8308 | 0.0017 | 190 | 0.6800 | 0.02699 | 280 | 0.3812 | 0.2201 | ,, |
| 90 | 0.8188 | 0.0024 | 200 | 0.6633 | 0.03268 | 281.3 | 0.3002 | 0.3002 | ,, |
| 100 | 0.8068 | 0.0033 | 210 | 0.6448 | 0.03968 | | | | ,, |

*Rectilinear diameter:* 0.4601 — 0.0005430 t° — 0.0000000906 t°² YOUNG (1910)

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 0 | 7.30 | 80 | 361.4 | 160 | 3328 | 240 | 14230 | YOUNG (1910) |
| 10 | 13.80 | 90 | 507.0 | 170 | 4111 | 250 | 16550 | ,, |
| 20 | 24.55 | 100 | 700.7 | 180 | 5020 | 260 | 19185 | ,, |
| 30 | 41.95 | 110 | 941.0 | 190 | 6063 | 270 | 22160 | ,, |
| 40 | 69.20 | 120 | 1248 | 200 | 7287 | 275 | 23795 | ,, |
| 50 | 109.65 | 130 | 1627 | 210 | 8684 | 278 | 24820 | ,, |
| 60 | 167.5 | 140 | 2100 | 220 | 10285 | 280 | 25560 | ,, |
| 70 | 250.3 | 150 | 2657 | 230 | 12105 | 281.3 | 26055 | ,, |

*Boiling point*

| | | |
|---|---|---|
| 102°65 | | LECAT |
| 102°67 | | THORPE and RODGER (1897) |
| 102°75 | (sample B) | YOUNG and THOMAS (1893) and YOUNG (1910) |
| 102°8 | ( ,, A) | ,, |

*Freezing point:* −84°8 TIMMERMANS

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.91994 | (sample A) | 0 | 0.92016 | (sample C) YOUNG and THOMAS |
| 13.3 | 0.90577 | ,, | 16.0 | 0.90303 | ,, ,, (1893) |
| 0 | 0.92010 | (sample B) | 0 | 0.92003 | (sample D) ,, |
| 14.1 | 0.90516 | ,, | 16.7 | 0.90216 | ,, ,, |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0.30 | 755.1 | Thorpe and | 79.46 | 305.7 | Thorpe and Rodger |
| 10.45 | 652.8 | Rodger (1897) | 90.63 | 276.8 | „ (1897) |
| 20.38 | 572.8 | „ | 98.28 | 259.2 | „ |
| 30.64 | 505.0 | „ | 25 | 546 | Kurnakow (1924) |
| 40.58 | 450.3 | „ | 50 | 374 | „ |
| 50.30 | 405.8 | „ | 70 | 312 | „ |
| 60.21 | 366.8 | „ | 25 | 541.5 | Dunstan, Thole and Benson |
| 71.35 | 329.5 | „ | 50 | 407 | „ (1914) |
| | | | 50 | 374 | Kurnakow, Perelmutter and Kanow (1916) |

## ETHYL *n*-BUTYRATE $n\text{-}C_3H_7.CO_2C_2H_5$

**Constants:** B.E. (1932)

*Boiling point*

| | |
|---|---|
| 121°5 | Lecat (passim) |
| 121°55 | B.E. (1932) |
| 121°7 | Pawlewski (1882) |

*Freezing point:* −100°8

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.89998 | B.E. (1932) | 25 | 0.8736 | Kurnakow (1924) and Kurnakow, Perelmutter and Kanow (1916) |
| 15 | 0.88440 | „ | | | |
| 30 | 0.86871 | „ | 50 | 0.8468 | „ |
| | | | 70 | 0.8279 | „ |
| 0 | 0.89957 | Elsässer (1881–83) | | | |
| 25 | 0.8744 | Baker (1913) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 25 | 628 | KURNAKOW (1924) | 15 | 711 | B.E. (1932) |
| 50 | 466 | ,, | 30 | 595 | ,, |
| 70 | 380 | ,, | 25 | 635 | DUNSTAN, THOLE and BENSON |
| 25 | 625.3 | BAKER (1913) | 50 | 458 | ,, (1914) |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 25.09 | B.E. (1932) | 20 | 24.54 | RICHARDS and COOMBS (1915) |
| 20 | 24.58 | ,, | | | |
| 30 | 23.26 | ,, | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.39231 | 1.39261 | — | 1.39475 | 1.39861 | 1.39946 | 1.40254 | 1.40440 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00046 | 47 | — | 47 | 48 | 48 | 49 | 47 | ,, |
| 20 | — | 1.39038 | 1.3928 | — | — | 1.38698 | — | 1.40069 | SCHJÄNBERG (1934–35) |

*n*-PROPYL *n*-BUTYRATE $n\text{-}C_3H_7.CO_2\ n\text{-}C_3H_7$

*Boiling point:* LECAT (passim), SCHIFF (1884), BROWN (1903), EYKMAN (1919) and PAWLEWSKI (1882); *density:* EYKMAN (1919) and GARTENMEISTER (1890); *viscosity:* GARTENMEISTER (1890); *refractive index:* EYKMAN (1919); *surface tension:* SCHIFF (1884); *boiling point* and *density:* ELSÄSSER (1881–83); *boiling point, density* and *refractive index:* MUNCH (1926); *boiling point, density, refractive index* and *heat of combustion:* SCHJÄNBERG (1934–35).

*Iso*-PROPYL and *n*-BUTYL *n*-BUTYRATES: $n\text{-}C_3H_7.CO_2CH(CH_3)_2$ and $n\text{-}C_3H_7.CO_2n\text{-}C_4H_9$. *Boiling point, density, refractive index* and *heat of combustion:* SCHJÄNBERG (1934–35).

*n*-BUTYL *n*-BUTYRATE: *boiling point* and *density:* MUNCH (1926).

*Iso*-BUTYL *n*-BUTYRATE: $n\text{-}C_3H_7.CO_2CH_2CH(CH_3)_2$. *Critical temperature, boiling point* and *heat of vaporisation:* BROWN (1903–06); *boiling point* and *density:* ELSÄSSER (1881–83); *boiling point:* LECAT; *boiling point* and *density:* MUNCH (1926); *boiling point, density, refractive index* and *heat of combustion:* SCHJÄNBERG (1934–35).

| | | *n*-BUTYRATES | | | | | |
|---|---|---|---|---|---|---|---|
| | | *n*-HEXYL-$n$-$C_3H_7.CO_2$ *n*-$C_6H_{13}$ | | *n*-HEPTYL-$n$-$C_3H_7.CO_2$ *n*-$C_7H_{15}$ | | *n*-OCTYL-$n$-$C_3H_7.CO_2$ *n*-$C_8H_{17}$ | |
| **Constants** | | BILTERYS (1935) | | BILTERYS (1935) | | GISSELEIRE (1935) | |
| *Boiling point:* | | 207°88 | | 225°87 | | 244°1 | |
| $\frac{dt}{dp}$ *(10 mm):* | | 0°52 | | 0°55 | | — | |
| *Freezing point:* | | −78°0 | | −57°5 | | −55°6 | |
| *Density:* | 0° | 0.8824 GARTENMEISTER (1886) | | | | | |
| | 0° | 0.88214 | | 0.88010 | | 0.87875 | |
| | 15° | 0.86944 | | 0.86782 | | 0.86686 | |
| | 30° | 0.85670 | | 0.85549 | | 0.85492 | |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 1678 | | 2064 | | 2491 | |
| | 30° | 1284 | | 1553 | | 1852 | |
| *Surface tension:* | 15° | — | | — | | 27.55 | |
| | 20° | — | | — | | 27.05 | |
| | 30° | — | | — | | 26.01 | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.41620 | 0.00038 | 1.42010 | 0.00036 | 1.42396 | 0.00034 |
| | Hα | 1.41601 | 39 | 1.42050 | 36 | 1.42443 | 34 |
| | He y. | 1.41875 | 39 | 1.42279 | 37 | 1.42674 | 35 |
| | He g. | 1.42295 | 40 | 1.42709 | 39 | 1.43080 | 34 |
| | Hβ | 1.42406 | 41 | 1.42802 | 39 | 1.43192 | 35 |

*sec*-BUTYL, AMYL, HEXYL, HEPTYL, OCTYL, UNDECYL *n*-BUTYRATES: $n$-$C_3H_7.CO_2$ *sec*.-$C_4H_9$, $C_5H_{11}$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_{11}H_{23}$: PICKARD and KENYON (1914)

## METHYL *iso*-BUTYRATE $(CH_3)_2CH.CO_2CH_3$

### Constants. — Polyphasic equilibria

*Critical constants*

| t° cr. | p cr. mm | d cr. | |
|---|---|---|---|
| 267.55 | 25740 | 0.3012 | YOUNG (1910) |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. | t° | L. | V. | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.91131 | 0.00007 | 110 | 0.7815 | 0.005882 | 220 | 0.5961 | 0.06289 | YOUNG (1910) |
| 10 | 0.9003 | 0.0001 | 120 | 0.7680 | 0.007628 | 230 | 0.5960 | 0.07722 | ,, |
| 20 | 0.8890 | 0.0002 | 130 | 0.7539 | 0.009718 | 240 | 0.5386 | 0.09615 | ,, |
| 30 | 0.8776 | 0.0004 | 140 | 0.7396 | 0.01224 | 250 | 0.5021 | 0.1218 | ,, |
| 40 | 0.8662 | 0.0006 | 150 | 0.7248 | 0.01533 | 256 | 0.4735 | 0.1437 | ,, |
| 50 | 0.8546 | 0.0009 | 160 | 0.7095 | 0.01903 | 260 | 0.4495 | 0.1623 | ,, |
| 60 | 0.8431 | 0.0013 | 170 | 0.6933 | 0.02345 | 263 | 0.4258 | 0.1838 | ,, |
| 70 | 0.8312 | 0.0018 | 180 | 0.6767 | 0.02869 | 265 | 0.4036 | 0.2033 | ,, |
| 80 | 0.8192 | 0.0025 | 190 | 0.6593 | 0.03490 | 266.5 | 0.3790 | 0.2268 | ,, |
| 90 | 0.8069 | 0.003361 | 200 | 0.6411 | 0.04228 | 267.55 | 0.3012 | 0.3012 | ,, |
| 100 | 0.7945 | 0.004472 | 210 | 0.6200 | 0.05141 | | | | ,, |

*Rectilinear diameter:* 0.4558 — 0.0005593 t° — 0.0000000689 t°² YOUNG (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| −10 | 6.22 | 70 | 355.2 | 150 | 3418 | 230 | 14700 | YOUNG (1910) |
| 0 | 12.15 | 80 | 505.0 | 160 | 4248 | 240 | 17190 | ,, |
| 10 | 22.40 | 90 | 707.0 | 150 | 5196 | 250 | 19925 | ,, |
| 20 | 38.90 | 100 | 952.0 | 180 | 6291 | 256 | 21740 | ,, |
| 30 | 65.45 | 110 | 1270.0 | 190 | 7557 | 260 | 23030 | ,, |
| 40 | 104.70 | 120 | 1662.0 | 200 | 9011 | 263 | 24080 | ,, |
| 50 | 162.0 | 130 | 2142.5 | 210 | 10690 | 265 | 24780 | ,, |
| 60 | 243.8 | 140 | 2733 | 220 | 12570 | 266.5 | 25345 | ,, |
| 23.0 | 48 | 51.1 | 172 | 76.1 | 445 | 102.5 | 1035 | SCHUMANN |
| 26.0 | 56 | 57.3 | 221 | 80.6 | 520 | 105.9 | 1137 | ,, |
| 32.3 | 75 | 61.9 | 264 | 84.4 | 592 | 108.7 | 1242 | ,, (1881) |
| 37.5 | 94 | 65.6 | 306 | 87.6 | 658 | 111.1 | 1316 | ,, |
| 41.6 | 113 | 69.3 | 348 | 91.0 | 734 | 112.7 | 1370 | ,, |
| 44.6 | 130 | 72.3 | 387 | 99.7 | 946 | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 92°26 | THORPE and RODGER (1897) | 92°3 | ELSÄSSER (1881) |
| 92°3 | $\frac{dt}{dp}$ *(10 mm):* 0°42 YOUNG and THOMAS (1893) and YOUNG (1910) | 92°4 | SCHIFF (1884) |
| | | 92°4 | BROWN (1903) |
| | | 92°5 | LECAT |

*Freezing point:* — 87°7 TIMMERMANS

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.91131 | Young (1910) | 30 | 0.8776 | Young (1910) |
| 10 | 0.9003 | „ | | | |
| 20 | 0.8890 | „ | 0 | 0.91118 | Elsässer (1881) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|
| 0.29 | 668.9 | 35.81 | 431.7 | 76.22 | 303.7 | Thorpe and Rodger |
| 9.40 | 591.5 | 44.66 | 393.3 | 79.77 | 281.3 | „ (1897) |
| 18.12 | 529.9 | 52.55 | 363.1 | 88.85 | 258.9 | „ |
| 28.98 | 466.0 | 62.72 | 328.9 | | | „ |

## ETHYL *iso*-BUTYRATE $(CH_3)_2CH.CO_2C_2H_5$

## Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 109°8 | Brown (1903) | 110°1 | Lecat (passim) |
| 109°9 | Schiff (1886) | 110°1 | Elsässer (1881–83) |
| 110°0 | Richards and Mathews (1908) | 110°2 | Schiff (1883–84) |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.89°367 | Elsässer (1881–83) |
| 20 | 0.8662 | Gartenmeister (1890) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 20 | 601 | Gartenmeister (1890) |
| 25 | 557 | Thole (1914) |

*Surface tension*

| t | $\gamma$ | |
|---|---|---|
| 5.2 | 24.79 | Schiff (1884) |
| 20 | 23.26 | Richards and Mathews (1908) |

*Refractive index:* Marsden and Evans (1937)

## *Iso*-PROPYL *iso*-BUTYRATE $(CH_3)_2CH.CO_2CH(CH_3)_2$

**Constants:** YOUNG and FORTEY (1902)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 10 | 6.55 | 80 | 201.1 | 140 | 1290 | 200 | 4742 |
| 20 | 11.95 | 90 | 289.4 | 150 | 1649 | 210 | 5700 |
| 30 | 20.9 | 100 | 406.0 | 160 | 2096 | 220 | 6785 |
| 40 | 35.05 | 110 | 553.4 | 170 | 2612 | 230 | 8058 |
| 60 | 89.0 | 120 | 743.9 | 180 | 3216 | | |
| 70 | 136.0 | 130 | 994 | 190 | 3916 | | |

*Boiling point:* 120°76

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.86867 | (sample A) |
| 0 | 0.86874 | (sample B) |
| 21.35 | 0.84708 | ,, |

*n*-PROPYL and *n*-AMYL *iso*-BUTYRATES: ELSÄSSER (1881—83).

## *Iso*-BUTYL *iso*-BUTYRATE $(CH_3)_2CH.CO_2CH_2.CH(CH_3)_2$

**Constants**

*Critical temperature:* 328°74 BROWN (1906)

*Saturated vapour pressure:* SCHUMANN (1882)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 65.3 | 43 | 90.6 | 122 | 117.3 | 315 | 144.7 | 730 |
| 69.1 | 50 | 94.0 | 140 | 120.3 | 347 | 150.7 | 843 |
| 74.7 | 60 | 97.8 | 161 | 124.8 | 398 | 154.3 | 928 |
| 77.3 | 70 | 100.4 | 178 | 128.0 | 441 | 159.8 | 1067 |
| 81.2 | 82 | 105.8 | 214 | 136.4 | 572 | 165.0 | 1217 |
| 85.8 | 100 | 109.4 | 243 | 141.6 | 662 | 168.1 | 1310 |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 148°6 | LECAT | −80°7 | TIMMERMANS |
| 148°65 | TIMMERMANS | | |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.87496 | ELSÄSSER (1881–83) |

## *n*-VALERATES

| | *n*-HEXYL- $n\text{-}C_4H_9.CO_2n\text{-}C_6H_{13}$ | *n*-HEPTYL- $n\text{-}C_4H_9.CO_2n\text{-}C_7H_{15}$ | *n*-OCTYL- $n\text{-}C_4H_9.CO_2n\text{-}C_8H_{17}$ |
|---|---|---|---|
| **Constants** | BILTERYS (1935) | BILTERYS (1935) | GISSELEIRE (1935) |
| *Boiling point:* | 226°30 | 245°21 | 261°6 |
| $\frac{dt}{dp}$ *(10 mm)* | 0°55 | 0°58 | — |
| *Freezing point:* | −63°1 | −46°4 | −42°5 |
| *Density:* 0° | 0.8796 GARTENMEISTER (1886) | 0.8785 GARTENMEISTER (1886) | — |
| 0° | 0.87992 | 0.87830 | 0.87712 |
| 15° | 0.86755 | 0.86625 | 0.86541 |
| 30° | 0.85524 | 0.85426 | 0.85361 |
| *Viscosity* $\eta \cdot 10^5$: 15° | 1974 | 2414 | 2908 |
| 30° | 1490 | 1787 | 2099 |
| *Surface tension:* 15° | — | — | 28.92 |
| 20° | — | — | 28.32 |
| 30° | — | — | 27.07 |

| *Refractive index:* 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
|---|---|---|---|---|---|---|
| | He r. | 1.42028 | — | 1.42369 | 0.00037 | 1.42727 | 0.00037 |
| | Hα | 1.42142 | 39 | 1.42395 | 36 | 1.42743 | 36 |
| | He y. | 1.42286 | 38 | 1.42635 | 38 | — | — |
| | He g. | 1.42711 | 39 | 1.43061 | 37 | — | — |
| | Hβ | 1.42809 | 38 | 1.43163 | 38 | 1.43784 | 36 |

METHYL-, ETHYL-, and *n*-PROPYL-*n* VALERATES: $n\text{-}C_4H_9.CO_2CH_3$, $n\text{-}C_4H_9.CO_2C_2H_5$, $n\text{-}C_4H_9.CO_2nC_3H_7$: *Boiling point* and *density:* ELSÄSSER (1881–83); *Boiling point, freezing point, density* and *viscosity:* GARTENMEISTER (1886–90). ($n\text{-}C_4H_9.CO_2C_2H_5$): *Boiling point:* LECAT.

*sec*-BUTYL, AMYL, HEXYL, HEPTYL, OCTYL, UNDECYL *n*-VALERATES: $n\text{-}C_4H_9.CO_2$ *sec*-$C_4H_9$, $C_5H_{11}$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_{11}H_{23}$: PICKARD and KENYON (1914).

## ETHYL TRIMETHYLACETATE $(CH_3)_3C.CO_2C_2H_5$

**Constants:** HOWARD, MEARS, FOOKSON, POMERANTZ and BROOKS (1947)

*Boiling point:* 118°35 $\frac{dt}{dp}$ *(10 mm):* 0°458

*Freezing point:* —89°55

*Density:* 20° 0.85467 25° : 0.84952

*Refractive index:* $n_D^{20°}$ 1.39061 $n_D^{25°}$ 1.38821 $\frac{dn}{dt}$ 0.00048

## METHYL *n*-CAPROATE $n\text{-}C_5H_{11}.CO_2CH_3$

**Constants:** Bilterys (1935)

*Boiling point:* 151°25 $\frac{dt}{dp}$ (10 mm): 0°48 *Freezing point:* —71°0

*Density*

| t° | d |
|---|---|
| 0 | 0.90327 |
| 15 | 0.88932 |
| 30 | 0.87528 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 936.2 |
| 30 | 771.2 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ |
|---|---|---|---|---|---|
| 15 | 1.40454 | 1.40488 | 1.40699 | 1.41104 | 1.41200 |
| $\frac{dn}{dt}$ | 0.00039 | 38 | 38 | 40 | 42 |

## *n*-CAPROATES

| | | *n*-PROPYL- $n\text{-}C_5H_{11}.CO_2nC_3H_7$ | | *n*-BUTYL- $n\text{-}C_5H_{11}.CO_2nC_4H_9$ | | *n*-AMY $n\text{-}C_5H_{11}.CO_2$ |
|---|---|---|---|---|---|---|
| **Constants:** Bilterys (1935); Hoback, Parsons and Bartlett (1944) (2) | | | | | | |
| *Boiling point:* | | 187°15 | | 207°74 | | 226°16 |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°51 | | 0°52 | | 0°53 |
| *Freezing point:* | | −74°0<br>−68°7 (2) | | −63°1<br>−64°3 (2) | | −50°0<br>−47°0 (2) |
| *Density:* | 0° | 0.88508 | | 0.88216 | | 0.88001 |
| | 15° | 0.87142 | | 0.86953 | | 0.86761 |
| | 30° | 0.85872 | | 0.85685 | | 0.85526 |
| | 0° | 0.88470 (2) | | 0.8821 (2) | | 0.8801 |
| | 25° | 0.8632 (2) | | 0.8623 (2) | | 0.8612 |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 1364 | | 1626 | | 1980 |
| | 30° | 1060 | | 1253 | | 1495 |
| *Refractive index:* | 15° | | $\frac{dn}{dt} \cdot 10^5$ | | $\frac{dn}{dt} \cdot 10^5$ | |
| | He r. | 1.41146 | 40 | 1.41613 | 39 | 1.42019 |
| | Hα | 1.41179 | 40 | 1.41651 | 39 | 1.42054 |
| | He y. | 1.41401 | 40 | 1.41877 | 40 | 1.42280 |
| | He g. | 1.41816 | 41 | 1.42295 | 41 | 1.42699 |
| | Hβ | 1.41914 | 41 | 1.42400 | 42 | 1.42809 |

## ETHYL-*n*-CAPROATE $n\text{-}C_5H_{11}.CO_2C_2H_5$

**Constants:** Simon (1929)

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 167°7 | Lecat | −67°5 | Simon (1929) |
| 167°85 | Simon (1929) | −67°6 | Van Bellinghen (1938) |

| *Density* | | | *Viscosity* | | |
|---|---|---|---|---|---|
| t | d | | t | $\eta \cdot 10^5$ | |
| 0 | 0.88956 | Simon | 15 | 1098 | Simon (1929) |
| 15 | 0.87583 | (1929) | 30 | 871 | „ |
| 30 | 0.86196 | „ | 25 | 929 | Dunstan, Thole and Benson (1914) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.40738 | 1.40763 | 1.40971 | 1.40985 | 1.41382 | 1.41480 | 1.41796 | 1.41907 |
| 25 | 1.40317 | 1.40342 | 1.40544 | 1.40559 | 1.40957 | 1.41055 | 1.41363 | 1.41475 |
| $\frac{dn}{dt}$ | 0.00042 | 42 | 43 | 44 | 43 | 43 | 43 | 43 |

## *n*-CAPROATES

| | | *n*-HEXYL- $n\text{-}C_5H_{11}.CO_2n\text{-}C_6H_{13}$ | | *n*-HEPTYL- $n\text{-}C_5H_{11}.CO n\text{-}_2C_7H_{15}$ | | *n*-OCTYL- $n\text{-}C_5H_{11}.CO_2n\text{-}C_8H_{17}$ | |
|---|---|---|---|---|---|---|---|
| **Constants** | | Bilterys (1935) | | Bilterys (1935) | | Gisseleire (1935) | |
| *Boiling point:* | | 245°43 | | 260°97 | | 275°2 | |
| *Freezing point:* | | −55°25 | | −34°4 | | −28°4 | |
| *Density:* | 0° | 0.87823 | | 0.87690 | | 0.87582 | |
| | 15° | 0.86617 | | 0.86508 | | 0.86418 | |
| | 30° | 0.85414 | | 0.85330 | | 0.85259 | |
| | 0° | — | | 0.8768 Gartenmeister (1886) | | — | |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 2391 | | 2896 | | 3451 | |
| | 30° | 1767 | | 2101 | | 2494 | |
| *Surface tension:* | 15° | — | | — | | 28.59 | |
| | 20° | — | | — | | 28.14 | |
| | 30° | — | | — | | 27.24 | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.42391 | 0.00040 | 1.42669 | 0.00036 | 1.42999 | 0.00034 |
| | Hα | 1.42418 | 39 | 1.42706 | 36 | 1.43011 | 34 |
| | He y. | 1.42637 | 39 | 1.42934 | 37 | 1.42256 | 34 |
| | He g. | 1.43054 | 40 | 1.43358 | 37 | 1.43687 | 34 |
| | Hβ | 1.43165 | 40 | 1.43459 | 37 | 1.43788 | 34 |

*n*-NONYL, UNDECYL, DODECYL, TRIDECYL, TETRADECYL, PENTADECYL *n*-CAPROATES: $n\text{-}C_5H_{11}.CO_2n\text{-}C_9H_{19}$, $C_{11}H_{23}$, $C_{12}H_{25}$, $C_{13}H_{27}$, $C_{14}H_{29}$, $C_{15}H_{31}$: Hoback, Parsons and Bartlett (1944).

*sec*-BUTYL, HEXYL, HEPTYL, OCTYL, NONYL *n*-CAPROATES: $n\text{-}C_5H_{11}.CO_2\text{-}sec C_4H_9$ $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_9H_{19}$: Pickard and Kenyon (1914).

## ETHYL OENANTHATE $n\text{-}C_6H_{13}.CO_2C_2H_5$

### Constants

*Boiling point*

| | | | |
|---|---|---|---|
| 188°55 | $\frac{dt}{dp}$ *(10 mm)*: 0°54 | | Gisseleire (1935) |
| 188°6 | | | Deffet (1931) |

*Freezing point*

| | | | |
|---|---|---|---|
| −66°1 | Deffet (1931) | −66°3 | Gisseleire (1935) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.88619 | Deffet (1931) | 0 | 0.88622 | Gisseleire (1935) |
| 15 | 0.87297 | „ | 15 | 0.87297 | „ |
| 30 | 0.85968 | „ | 30 | 0.85973 | „ |
| 0 | 0.8860 | Gartenmeister (1886) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 1388 | Deffet (1931) | 15 | 1355 | Gisseleire (1935) |
| 30 | 1071 | „ | 30 | 1050 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 27.02 | Hennaut-Roland and Lek | 15 | 26.91 | Gisseleire (1935) |
| 20 | 26.43 | „ (1931) | 20 | 26.43 | „ |
| 30 | 25.45 | „ | 30 | 25.46 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.41286 | 1.41321 | 1.41540 | 1.41947 | 1.42050 | 1.42351 | 1.42486 | Deffet (1931) |
| $\frac{dn}{dt}$ | 0.00043 | 42 | 43 | 43 | 44 | 45 | 44 | „ |
| 15 | 1.41289 | 1.41312 | 1.41537 | 1.41956 | 1.42059 | — | — | Gisseleire (1935) |
| $\frac{dn}{dt}$ | 0.00040 | 40 | 40 | 39 | 40 | — | — | „ |

## OENANTHATES

| | METHYL- $n$-$C_6H_{13}.CO_2CH_3$ | | $n$-PROPYL- $nC_6H_{13}.CO_2n$-$C_3H_7$ | | $n$-BUTYL- $n$-$C_6H_{13}.CO_2n$-$C_4H_9$ | | $n$-AMYL- $n$-$C_6H_{13}.CO_2n$-$C_5H_{11}$ | |
|---|---|---|---|---|---|---|---|---|
| **Constants:** Bilterys (1935); Hoback, Parsons and Bartlett (1944) (2) | | | | | | | | |
| B.P. | 173°80 | | 207°94 | | 226°18 | | 245°44 | |
| $\frac{dt}{dp}$ *(10 mm)* | 0°50 | | 0°53 | | 0°55 | | — | |
| F.P. | −55°80 | | −64°8<br>−63°5 (2) | | −68°4<br>−67°5 (2) | | −49°5<br>−49°0 (2) | |
| D: 0° | 0.89802 | | 0.88266 | | 0.88034 | | 0.87850 | |
| 15° | 0.88459 | | 0.86982 | | 0.86796 | | 0.86634 | |
| 30° | 0.87115 | | 0.85705 | | 0.85553 | | 0.85427 | |
| 0° | — | | 0.8823 (2) | | 0.8799 (2) | | 0.8780 (2) | |
| 25° | — | | 0.8610 (2) | | 0.8592 (2) | | 0.8580 (2) | |
| $\eta \cdot 10^5$: 15° | 1210 | | 1680 | | 1982 | | 2393 | |
| 30° | 947 | | 1285 | | 1495 | | 1769 | |
| n: 15° | | $\frac{dn}{dt} \cdot 10^5$ | | $\frac{dn}{dt} \cdot 10^5$ | | $\frac{dn}{dt} \cdot 10^5$ | | $\frac{dn}{dt} \cdot 10^5$ |
| He r. | 1.41094 | 40 | 1.41641 | 39 | 1.42020 | 40 | 1.42361 | 38 |
| Hα | 1.41125 | 40 | 1.41672 | 39 | 1.42056 | 40 | 1.42397 | 38 |
| He y. | 1.41334 | 41 | 1.41894 | 39 | 1.42280 | 40 | 1.42687 | 38 |
| He g. | 1.41752 | 39 | 1.42310 | 40 | 1.42698 | 40 | 1.43043 | 38 |
| Hβ | 1.41844 | 39 | 1.42408 | 40 | 1.42801 | 40 | 1.43155 | 38 |

## OENANTHATES

| | | *n*-HEXYL- $n\text{-}C_6H_{13}.CO_2n\text{-}C_6H_{13}$ | | *n*-HEPTYL- $n\text{-}C_6H_{13}.CO_2n\text{-}C_7H_{15}$ | | *n*-OCTYL- $n\text{-}C_6H_{13}.CO_2n\text{-}C_8H_{17}$ | |
|---|---|---|---|---|---|---|---|
| **Constants** | | BILTERYS (1935) | | BILTERYS (1935) | | GISSELBRECHT (1935) | |
| *Boiling point:* | | 260°89 | | 277°21 | | 290°75 | |
| $\frac{dt}{dp}$ *(10 mm):* | | 0°60 | | 0°62 | | — | |
| *Freezing point:* | | −47°9 | | −33°3 | | −21°5 | |
| *Density:* | 0° | — | | 0.8760 GARTENMEISTER (1886) | | — | |
| | 0° | 0.87681 | | 0.87566 | | 0.87472 | |
| | 15° | 0.86507 | | 0.86420 | | 0.86341 | |
| | 30° | 0.85327 | | 0.85277 | | 0.85200 | |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 2870 | | 3437 | | 3998 | |
| | 30° | 2082 | | 2434 | | 2846 | |
| *Surface tension:* | 15° | — | | — | | 28.65 | |
| | 20° | — | | — | | 28.12 | |
| | 30° | — | | — | | 27.05 | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.42675 | 0.00039 | 1.42918 | 0.00035 | 1.43215 | 0.00032 |
| | Hα | 1.42711 | 38 | 1.42948 | 35 | 1.43252 | 32 |
| | He y. | 1.42939 | 38 | 1.43183 | 35 | 1.43488 | 32 |
| | He g. | 1.43361 | 39 | 1.43604 | 36 | 1.43925 | 33 |
| | Hβ | 1.43472 | 40 | 1.43715 | 36 | 1.44026 | 32 |

*sec*-BUTYL, HEXYL, HEPTYL, OCTYL, UNDECYL OENANTHATES: $n\text{-}C_6H_{13}.CO_2$ *sec.*-$C_4H_9$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_{11}H_{23}$: PICKARD and KENYON (1914).

## ETHYL *n*-CAPRYLATE $n\text{-}C_7H_{15}.CO_2C_2H_5$

**Constants:** DEFFET (1931)

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 208·35 | LECAT | α −43·1 | DEFFET (1931) |
| 208°5 | DEFFET (1931) | α −43°2 | VAN BELLINGHEN (1938) |
| | | β −59°2 | ,, |

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 0 | 0.88351 | 15 | 1722 | 15 | 27.39 | HENNAUT-ROLAND and LEK (1931) |
| 15 | 0.87075 | 30 | 1321 | 20 | 26.91 | " |
| 30 | 0.85802 | | | 30 | 25.97 | " |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.41738 | 1.41775 | 1.41989 | 1.42434 | 1.42524 | 1.42813 | 1.4294 |
| $\frac{dn}{dt}$ | 0.00040 | 40 | 40 | 40 | 40 | 41 | — |

## *n*-CAPRYLATES

| | *n*-PROPYL- $n\text{-}C_7H_{15}.CO_2n\text{-}C_3H_7$ | *n*-BUTYL- $n\text{-}C_7H_{15}.CO_2n\text{-}C_4H_9$ | *n*-AMYL- $n\text{-}C_7H_{15}.CO_2n\text{-}C_5H_{11}$ |
|---|---|---|---|
| **Constants:** HOBACK, PARSONS and BARTLETT (1944) (2) | | | |
| | BILTERYS (1935) | BILTERYS (1935) | GISSELEIRE (1935) |
| *Boiling point:* | 226°43 | 245°02 | 260°21 |
| $\frac{dt}{dp}$ *(10 mm):* | — | 0°58 | — |
| *Freezing point:* | −46°2<br>−45°0 (2) | −41°9<br>−43°0 (2) | −34°8<br>−34°5 (2) |
| *Density:* 0° | 0.88230 | 0.87880 | 0.87714 |
| 15° | 0.87000 | 0.86671 | 0.86525 |
| 30° | 0.85773 | 0.85479 | 0.85345 |
| 0° | 0.8820 (2) | 0.8786 (2) | 0.8770 (2) |
| 25° | 0.8616 (2) | 0.8584 (2) | 0.8562 (2) |
| *Viscosity* $\eta \cdot 10^5$: 15° | 2198 | 2442 | 2916 |
| 30° | 1654 | 1805 | 2097 |
| *Surface tension:* 15° | — | — | 28.18 |
| 20° | — | — | 27.80 |
| 30° | — | — | 26.92 |
| *Refractive index:* 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| He r. | 1.42084 | 0.00036 | 1.42381 | 0.00037 | 1.42755 | 0.00039 |
| Hα | 1.42120 | 36 | 1.42418 | 37 | 1.42781 | 36 |
| He y. | 1.42351 | 37 | 1.42647 | 37 | 1.43019 | 36 |
| He g. | 1.42770 | 38 | 1.43083 | 38 | 1.43441 | 36 |
| Hβ | 1.42863 | 37 | 1.43176 | 38 | 1.43521 | 36 |

## *n*-CAPRYLATES

| | | *n*-HEXYL- $n\text{-}C_7H_{15}.CO_2n\text{-}C_6H_{13}$ | | *n*-HEPTYL- $n\text{-}C_7H_{15}.CO_2n\text{-}C_7H_{15}$ | | *n*-OCTYL- $n\text{-}C_7H_{15}.CO_2n\text{-}C_8H_{17}$ | |
|---|---|---|---|---|---|---|---|
| **Constants** | | BILTERYS (1935) | | GISSELEIRE (1935) | | GISSELEIRE (1935) | |
| *Boiling point:* | | 277°44 | | 290°6 | | 306°8 | |
| $\frac{dt}{dp}$ *(10 mm):* | | 0°62 | | — | | — | |
| *Freezing point:* | | −30°6 | | −10°2 | | −15°1 | |
| *Density:* | 0° | 0.87564 | | 0.87472 | | 0.87403 | |
| | 15° | 0.86414 | | 0.86335 | | 0.86292 | |
| | 30° | 0.85270 | | 0.85204 | | 0.85172 | |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 3445 | | 3981 | | 4825 | |
| | 30° | 2453 | | 2828 | | 3684 | |
| *Surface tension:* | 15° | — | | 28.76 | | 28.85 | |
| | 20° | — | | 28.24 | | 28.29 | |
| | 30° | — | | 27.28 | | 27.15 | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.42965 | 0.00037 | 1.43220 | 0.00032 | 1.43417 | 0.00033 |
| | Hα | 1.43001 | 37 | 1.43256 | 33 | 1.43451 | 33 |
| | He y. | 1.43230 | 37 | 1.43492 | 33 | 1.43698 | 33 |
| | He g. | 1.43668 | 37 | 1.43929 | 33 | 1.44125 | 34 |
| | Hβ | 1.43769 | 37 | 1.44024 | 33 | 1.44225 | 33 |

For METHYL *n*-CAPRYLATE and PELARGONATE, there are no reliable data.

*sec*-BUTYL, HEPTYL, OCTYL *n*-CAPRYLATES: $n\text{-}C_7H_{15}.CO_2$ $sec\text{-}C_4H_9$, $C_7H_{15}$, $C_8H_{17}$ PICKARD and KENYON (1914).

*n*-PROPYL, *n*-BUTYL, *n*-AMYL *n*-PELARGONATES:

$n\text{-}C_8H_{17}.CO_2n\text{-}C_3H_7$, $n\text{-}C_4H_9$, $n\text{-}C_5H_{11}$: HOBACK, PARSONS and BARTLETT (1944).

| | | ETHYL *n*-PELARGONATE $n$-$C_8H_{17}.CO_2C_2H_5$ | | ETHYL *n*-CAPRATE $n$-$C_9H_{19}.CO_2C_2H_5$ | |
|---|---|---|---|---|---|
| **Constants:** DEFFET (1931) | | | | | |
| *Boiling point:* | | 227°0<br>227° BROWN (1903) | | 244°9 | |
| *Freezing point:* | | $\beta$ −36°7<br>$\alpha$ −55°0 VAN BELLINGHEN<br>$\beta$ −36°8 „ (1938)<br>$\gamma$ −43°6 „ | | $\beta$ −19°9<br>$\beta$ −19°95 VAN BELLINGHEN (1938)<br>$\gamma$ −30°6 „<br>$\alpha$ −18°0 HOERR, HARWOOD and RALSTON (1944)<br>$\beta$ −19°5 „ | |
| *Density:* | 0° | 0.888156 | | 0.88027 | |
| | 15° | 0.86920 | | 0.86811 | |
| | 30° | 0.85693 | | 0.85599 | |
| *Viscosity* $\eta \cdot 10^5$ | 15° | 2106 | | 2624 | |
| | 30° | 1572 | | 1873 | |
| *Surface tension:* | 15° | 28.02 HENNAUT-ROLAND and LEK (1931) | | — | |
| | 20° | 27.57 „ | | — | |
| | 30° | 26.72 „ | | — | |
| *Refractive index:* | 15° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| | He r. | 1.42147 | 0.00041 | 1.42506 | 0.00038 |
| | H$\alpha$ | 1.42183 | 41 | 1.42542 | 38 |
| | He y. | 1.42415 | 42 | 1.42771 | 38 |
| | He g. | 1.42839 | 41 | 1.43202 | 39 |
| | H$\beta$ | 1.42944 | 41 | 1.43307 | — |
| | He v. | 1.43247 | 42 | 1.43604 | 39 |
| | H$\gamma$ | 1.43367 | — | 1.43723 | 39 |

ETHYL LAURATE: $C_{11}H_{23}.CO_2C_2H_5$: EYKMAN (1919).

ETHYL *n*-UNDECOATE, *n*-DODECOATE (LAURATE) and *n*-TRIDECOATE: $n$-$C_{10}H_{21}.CO_2C_2H_5$ $n$-$C_{11}H_{23}.CO_2C_2H_5$, $n$-$C_{12}H_{25}.CO_2C_2H_5$: *Melting point* and *polymorphism;* VAN BELLINGHEN (1938).

*sec*-BUTYL, AMYL, HEXYL, HEPTYL, OCTYL, NONYL, DECYL, UNDECYL, DODECYL, TRIDECYL, *n*-PELARGONATES, *n*-UNDECOATES, *n*-DODECOATES (LAURATES): $n$-$C_8H_{17}.CO_2R$, $n$-$C_{10}H_{21}.CO_2R$, $n$-$C_{11}H_{23}.CO_2R$ (R = alkyl): PICKARD and KENYON (1914).

METHYL and ETHYL MYRISTATES: $C_{13}H_{27}.CO_2CH_3$ and $C_2H_5$: GARNER and RUSHBROOKE, (1927); HOERR, HARWOOD and RALSTON (1944).

*sec*-BUTYL, HEXYL, HEPTYL, OCTYL, UNDECYL MYRISTATES: $C_{13}H_{27}.CO_2$ *sec.* $C_4H_9$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_{11}H_{23}$; PICKARD and KENYON (1914).

## ETHYL STEARATE $n\text{-}C_{17}H_{35}.CO_2C_2H_5$

*Melting point:*

| St. form. | Unst. form. | |
|---|---|---|
| 33°4 | 30°9 | Van Bellinghen (1938) |
| 33°8 | 31°05 | Hoerr, Harwood and Ralston (1944) |

*Melting curve:*

| St. form. | | | Unst. form. | | |
|---|---|---|---|---|---|
| t° | p kg/cm² | | t° | p kg/cm² | |
| 33.4 | 1 | Deffet (1940) | 30.9 | 1 | Deffet (1940) |
| 37.50 | 192 | „ | 35.00 | 184 | „ |
| 40.00 | 318 | „ | 37.50 | 307 | „ |
| 50.00 | 780 | „ | 40.00 | 428 | „ |
| 53.00 | 925 | „ | 45.00 | 683 | „ |
| | | | 50.00 | 927 | „ |

The METHYL and ETHYL PALMITATES have not been studied carefully.

*n*-PROPYL PALMITATE and STEARATE: $C_{15}H_{31}.CO_2n\text{-}C_3H_7$ and $C_{17}H_{35}.CO_2\ n\text{-}C_3H_7$: Eykman (1919).

*sec*-BUTYL, HEXYL, HEPTYL, OCTYL, UNDECYL PALMITATES: $n\text{-}C_{15}H_{31}.CO_2\ sec.\ C_4H_9$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$, $C_{11}H_{23}$: Pickard and Kenyon (1914).

*sec*-BUTYL, HEXYL, HEPTYL, OCTYL STEARATES: $n\text{-}C_{17}H_{35}.CO_2\ sec.\ C_4H_9$, $C_6H_{13}$, $C_7H_{15}$, $C_8H_{17}$: Pickard and Kenyon (1914).

## ETHYLENE GLYCOL DIACETATE or ETHYLENE DIACETIN $(CH_3CO_2.CH_2)_2$

*Saturated vapour pressure, density* and *refractive index:* Taylor and Rinkenbach (1926) *Boiling point:* Lecat.

## GLYCERIDES

TRIBUTYRIN, TRICAPROIN and TRICAPRYLIN: $(CH_2CO_2R)_2.CHCO_2R$: R = $n\text{-}C_3H_7$; R = $n\text{-}C_5H_{11}$; R = $n\text{-}C_7H_{15}$). Scheij (1899)

## TRICAPRIN $(CH_2CO_2n\text{-}C_9H_{19})_2.CHCO_2n\text{-}C_9H_{19}$

### Constants

*Freezing point*

| | |
|---|---|
| 31°0 | Loskit (1928) |
| 31°1 | Scheij (1899) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 40 | 0.9204 | JOGLEKAR and WATSON | 40 | 0.9205 | SCHEIJ (1899) |
| 60 | 0.9059 | „ (1928) | 60 | 0.9057 | „ |
| 70 | 0.8986 | „ | | | |
| 80 | 0.8913 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 45 | 1006 | JOGLEKAR and WATSON | 75 | 625 | JOGLEKAR and WATSON |
| 60 | 777 | „ (1928) | 85 | 551 | „ (1928) |
| 70 | 688 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 40 | 28.7 | JOGLEKAR and WATSON | 70 | 26.6 | JOGLEKAR and WATSON |
| 60 | 27.3 | „ (1928) | 80 | 25.9 | „ (1928) |

*Refractive index*

| t° | $n_D$ | t° | $n_D$ | |
|---|---|---|---|---|
| 40 | 1.44461 | 60 | 1.43697 | SCHEIJ (1899) |

## TRILAURIN $C_3H_5(CO_2.n\text{-}C_{11}H_{23})_3$

### Constants

*Melting point:* 46°4 SCHEIJ (1899)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 60 | 0.8943 | JOGLEKAR and WATSON | 60 | 0.8944 | SCHEIJ (1899) |
| 70 | 0.8872 | „ (1928) | | | |
| 80 | 0.8801 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 45 | 2198 | JOGLEKAR and WATSON | 75 | 911 | JOGLEKAR and WATSON |
| 60 | 1359 | „ (1928) | 80 | 809 | „ (1928) |
| 70 | 1030 | „ | 85 | 722 | „ |

*Surface tension* *Refractive index*

| t° | $\gamma$ | | t° | $n_D$ | |
|---|---|---|---|---|---|
| 60 | 27.9 | JOGLEKAR and WATSON | 60 | 1.44039 | SCHEIJ (1899) |
| 70 | 27.3 | „ (1928) | | | |
| 80 | 26.6 | „ | | | |

α- and β-MONOPALMITIN: $C_3H_5(OH)_2CO_2n\text{-}C_{15}H_{31}$: CLARKE and STEGEMAN (1940)

## TRIPALMITIN $C_3H_5(CO_2n\text{-}C_{15}H_{31})_3$

**Constants**

*Freezing point*

| | |
|---|---|
| 64°8 | LOSKIT (1928) |
| 65°1 | SCHEIJ (1899) |
| 65°5 | GUTH (1903) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 70 | 0.8730 | JOGLEKAR and WATSON | 80 | 0.8657 | SCHEIJ (1899) |
| 80 | 0.8663 | „ (1928) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 70 | 1679 | JOGLEKAR and WATSON | 80 | 1292 | JOGLEKAR and WATSON |
| 75 | 1467 | „ (1928) | 85 | 1144 | „ (1928) |

*Surface tension* *Refractive index*

| t° | $\gamma$ | | t° | $n_D$ | |
|---|---|---|---|---|---|
| 70 | 28.3 | JOGLEKAR and WATSON | 80 | 1.43807 | SCHEIJ (1899) |
| 80 | 27.6 | „ (1928) | | | |

## ETHYL CARBONATE $CO_3(C_2H_5)_2$

**Constants:** B.E. (1930)

*Boiling point*

| | | *Freezing point* | |
|---|---|---|---|
| 126°5<br>126°8 | $\frac{dt}{dp}$ *(10 mm)*: 0°42 LECAT<br>„ 0°42 B.E. (1930) | −43°0 | B.E. (1930) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.99707 | B.E. (1930) | 25 | 0.96926 | BOWDEN and BUTLER (1939) |
| 15 | 0.98043 | „ | | | |
| 30 | 0.96393 | „ | | | |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 868 | B.E. (1930) | 15 | 26.94 | B.E. (1930) |
| 30 | 698 | „ | 20 | 26.44 | „ |
| 25 | 747.6 | BOWDEN and BUTLER (1939) | 30 | 25.47 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.38422 | 1.38452 | — | 1.38654 | 1.39011 | 1.39085 | 1.39379 | 1.39489 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00040 | 40 | — | 39 | 40 | 40 | 42 | 42 | „ |
| 25 | — | — | 1.38287 | — | — | — | — | — | BOWDEN and BUTLER (1939) |

*Dielectric constant:* 20° 2.819 PIETTE (1947).

## ETHYL OXALATE $(CO_2C_2H_5)_2$

**Constants:** B.E. (1930)

*Boiling point*

| | | | |
|---|---|---|---|
| 185°19 | $\frac{dt}{dp}$ *(10 mm)*: | 0°51 | LOUGUININE (1880) |
| 185°4 | „ | 0°52 | B.E. (1930) |
| 185°65 | „ | 0°57 | LECAT (passim) |

*Freezing point:* −40°6

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 12 | 1.0879 | SCHWERS (1911) | 0 | 1.10169 | B.E. (1930 |
| 13.45 | 1.08631 | „ | 15 | 1.08426 | „ |
| 33.6 | 1.06270 | „ | 30 | 1.06687 | „ |
| 53.45 | 1.03963 | „ | 15.75 | 1.0834 | AUWERS (1918) |
| 75.75 | 1.01269 | „ | 25 | 1.0725 | DUNSTAN, HILDITCH and THOLE (1913) |
| 95.65 | 1.08829 | „ | | | |
| | | | 20 | 1.0785 | MEARES (1949) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2311 | B.E. (1930) |
| 30 | 1618 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 32.83 | B.E. (1930) |
| 20 | 32.22 | „ |
| 30 | 31.03 | „ |

*Refractive index*

| t | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40974 | 1.41011 | — | 1.41239 | 1.41656 | 1.41761 | 1.42086 | 1.42225 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00042 | 41 | — | 42 | 42 | 41 | 42 | 41 | „ |
| 12 | — | — | 1.4137 | — | — | — | — | — | SCHWERS (1911) |

*sec*-OCTYL OXALATE: $(CO_2sec\text{-}C_8H_{17})_2$: *Specific rotatory power for various wave lengths*: LOWRY and RICHARDS (1924).

## ETHYL MALONATE $(CO_2C_2H_5)_2.CH_2$

**Constants:** B.E. (1934)

*Boiling point*

| | |
|---|---|
| 199°30 | $\frac{dt}{dp}$ *(10 mm)*: 0°58 B.E. (1934) |
| 199°35 | „ 0°58 LECAT |

*Freezing point* −51°5

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.07623 | B.E. (1934) | 16.8 | 1.0581 | EYKMAN (1893–1919) |
| 15 | 1.06040 | „ | 20 | 1.0550 | KARVONEN (1917) |
| 30 | 1.04460 | „ | 25 | 1.0501 | DUNSTAN, HILDITCH and THOLE (1913) |
| 16.6 | 1.0587 | BRÜHL (1894) | | | |
| 20 | 1.0553 | „ | 30 | 1.0445 | BECK, MACBETH and PENNYCUICK (1932) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 2377 | B.E. (1934) | 25 | 1875 | DUNSTAN, HILDITCH and THOLE (1913) |
| 30 | 1753 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 32.31 | B.E. (1934) | 30 | 30.56 | BECK, MACBETH and PENNYCUCK (1932) |
| 20 | 31.71 | „ | | | |
| 30 | 30.49 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41354 | 1.41393 | — | 1.41626 | 1.42034 | 1.42140 | 1.42450 | — | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00038 | 37 | — | 39 | 38 | 38 | 40 | — | „ |
| 16.8 | — | 1.41342 | — | — | — | 1.42048 | — | — | EYKMAN (1893–1919) |
| 80 | — | 1.38579 | — | — | — | 1.39234 | — | — | „ |
| 20 | — | 1.41413 | 1.41618 | — | — | 1.42120 | — | 1.42356 | KARVONEN (1917) |

## METHYL SUCCINATE $(CH_2.CO_2CH_3)_2$

### Constants

*Boiling point*

| | |
|---|---|
| 195°5 | Lecat (passim) |
| 195°9 | Viseur (1926) |

*Freezing point*

| | |
|---|---|
| 18°2 | Viseur (1926) |
| 18°2 | Kendall and Booge (1916) |
| 18°5 | Perkin (1884–85) |
| 19° | Bruni and Gorni (1900) |
| 19°5 | Bruni and Amadori (1910) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 1.12525 | Viseur (1926) | 15 | 1.12513 | Perkin (1884–85) |
| 18 | 1.12189 | „ | 25 | 1.11393 | „ |
| 20 | 1.11961 | „ | | | |
| 25 | 1.11398 | „ | | | |

*Magnetic rotatory power:* 18°2 0.8630 Perkin (1884–85)

## ETHYL SUCCINATE $(CH_2.CO_2C_2H_5)_2$

### Constants

*Boiling point*

| | |
|---|---|
| 217°25 | Lecat |
| 217°75 | Viseur (1926) |

*Freezing point*

| | |
|---|---|
| −20°8 | Schneider (1897) |
| −20°8 | Kendall and Booge (1916) |
| −21°3 | Timmermans |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 1.04554 | Perkin (1884) | 19 | 1.0416 | Patterson, Henderson and Fairlie (1907) |
| 25 | 1.03529 | „ | | | |
| 15 | 1.04562 | Viseur (1926) | 24.8 | 1.03543 | „ |
| 25 | 1.0349 | Smyth and Walls (1931) | 28.04 | 1.03228 | „ |
| | | | 31.75 | 1.02841 | „ |

*Refractive index:* $n_D^{20°}$: 1.42010 SMYTH and WALLS (1931)

*Magnetic rotatory power:* 17°8 0.9053 PERKIN (1884)

### *n*-PROPYL SUCCINATE $(CH_2CO_2n\text{-}C_3H_7)_2$

*Boiling point, density* and *magnetic rotatory power;* PERKIN (1888); *melting point:* −11°0: TIMMERMANS.

## ETHYL GLUTARATE $(CH_2)_3(CO_2C_2H_5)_2$

**Constants:** SERWY (1933)

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 233°68 | | −23°80 | TIMMERMANS |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.04202 | SERWY (1933) | 14.9 | 1.0272 | EYKMAN (1919) |
| 15 | 1.02704 | „ | 25 | 1.0170 | SMYTH and WALLS (1931) |
| 30 | 1.01210 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 3260 | SERWY (1933) |
| 30 | 2311 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 1.42294 | 1.42333 | — | 1.42570 | 1.42982 | 1.43086 | 1.43382 | 1.43820 | SERWY (1933) |
| $\frac{n}{i}$ | 0.00039 | 39 | — | 39 | 40 | 41 | 41 | — | „ |
| 0 | — | — | 1.42400 | — | — | — | — | — | SMYTH and WALLS (1931) |

## ETHYL ADIPATE $(CH_2)_4(CO_2C_2H_5)_2$

| Constants | | Chiurdoglu (1935) | Serwy (1933) | |
|---|---|---|---|---|
| *Boiling point:* | | 133°8/15 mm | 131°/13 mm | |
| *Freezing point:* | | −19°8 | −19°9 | |
| *Density:* | 0° | 1.02590 | 1.02589 | |
| | 15° | 1.01165 | 1.01165 | |
| | 20° | 1.00693 | — | |
| | 30° | 0.99440 | 0.99744 | |
| *Viscosity* $\eta \cdot 10^5$: | 15° | 3881 | 3871 | |
| | 30° | 2705 | 2648 | |
| *Refractive index:* | | 20° | 15° | $\frac{dn}{dt}$ |
| | He r. | — | 1.42673 | 0.00039 |
| | Hα | 1.42557 | 1.42708 | 38 |
| | He y. | 1.42770 | 1.42924 | 37 |
| | He g. | — | 1.43362 | 38 |
| | Hβ | 1.43279 | 1.43463 | 38 |
| | He v. | — | 1.43783 | 40 |
| | Hγ | 1.43697 | 1.44335 | 38 |

*n*-AMYL OXALATE: $(CO_2n\text{-}C_5H_{11})_2$; *n*-PROPYL and *n*-AMYL MALONATES: $CH_2(CO_2n\text{-}C_3H_7)_2$ and $CH_2(CO_2n\text{-}C_5H_{11})_2$; *n*-PROPYL, *n*-BUTYL and *n*-AMYLGLUTARATES: $(CH_2)_3(CO_2n\text{-}C_3H_7)_2$, $(CH_2)_3(CO_2n\text{-}C_4H_9)_2$, $(CH_2)_3(CO_2n\text{-}C_5H_{11})_2$; *n*-PROPYL and *n*-BUTYL PIMELATES: $(CH_2)_5(CO_2n\text{-}C_3H_7)_2$ and $(CH_2)_5(CO_2n\text{-}C_4H_9)_2$: Serwy (1933).

| | | |
|---|---|---|
| METHYL and ETHYL PIMELATES | $(CH_3CO_2)_2(CH_2)_5$ | *Melting point, density, surface tension* and *refractive index*. Vogel (1934). |
| „ „ SUBERATES | $(C_2H_5CO_2)_2(CH_2)_6$ | |
| „ „ AZELATES | $(C_2H_5CO_2)_2(CH_2)_7$ | |

METHYL-ALKYLMALONATES: Vogel (1934).
$(CH_3CO_2)_2.CHR$ (R=$CH_3$; $C_2H_5$; $n$-$C_3H_7$)
$(CH_3CO_2)_2.CR_2$ [$R_2$=$(CH_3)_2$; $CH_3C_2H_5$; $CH_3n$-$C_3H_7$; $C_2H_5$ $n$-$C_3H_7$; $(n$-$C_3H_7)_2$]

ETHYL DIMETHYLSUCCINATE: $(C_2H_5CO_2.CHCH_3)_2$: *Refractive index* and *heat of combustion:* Berner (1926).

*iso*-BUTYL *l*. LACTATE
*dl. sec.* „ *l.* „
*d.* „ „ *d.* „
*d.* „ „ *l.* „
*tert.* „ *l.* „
*iso-* „ *l.* „

$CH_3.CHOH.CO_2C_4H_9$ *Density* and *rotatory power:* Wood, Such and Scarf (1926)

*Boiling point:* 182°15 Lecat.

METHYL and ETHYL MALATES: $RCO_2.CHOH.CH_2.CO_2R$: ($R=CH_3$; $R=C_2H_5$) *Boiling point, density, refractive index* and *natural* and *magnetic rotatory power;* HERNQUIST (1914).

METHYL TARTRATES: MITCHELL and SMITH (1913) $(CH_3CO_2.CHOH)_2$: The densities of the racemate and the *l.* tartrate are not in agreement; they are also different from the values of WOOD and NICHOLAS (1928) and PATTERSON (1904).

*Rotatory dispersion;* LOWRY and DICKSON (1915).

*Heat of combustion;* BERNER (1926) and VERKADE and COOPS (1928).

METHYL *Meso*-TARTRATES $(CH_3CO_2.CHOH)_2$

*Melting point* and *heat of combustion;* BERNER (1926).

*Melting point;* MARCKWALD and KARSZAG (1909).

ETHYL TARTRATE $(C_2H_5CO_2.CHOH)_2$

*Density;* PATTERSON (1901–1908–1916); *melting point, density* and *rotatory power;* WOOD and NICHOLAS (1928); *density, natural* and *magnetic rotatory power;* PERKIN (1887).

The densities of the racemate and the *d.* tartrate (Perkin) agree, but are different from all other values, which moreover, are incompatible with one another.

*Rotatory dispersion;* LOWRY and DICKSON (1915).

*Melting point, density, refractive index, heat of combustion;* BERNER (1926).

ETHYL *Meso*-TARTRATE $(C_2H_5CO_2.CHOH_2)$

*Melting point* and *heat of combustion;* BERNER (1926).

*Boiling* and *melting points, density* and *refractive index*: KUHN and WAGNER-JAUREGG (1928).

*sec*-OCTYL METHOXYACETATE $CH_3OCH_2CO_2sec\text{-}C_8H_{17}$

*Density* and *rotatory power;* RULE and MITCHELL (1926).

METHYL, ETHYL, *n*-PROPYL, *n*-BUTYL, *iso*-BUTYL, *iso*-AMYL, *sec*-PROPYL, *sec*-BUTYL CROTONATES: $CH_3.CH=CHCO_2R$ ($R=CH_3$, $C_2H_5$, $C_3H_7$, $C_4H_9$, $(CH_3)_2CH.CH_2$, $(CH_3)_2CH.(CH_2)_2$, $(CH_3)_2CH$, $C_2H_5.CH(CH_3)$: *Boiling point, density, refractive index* and *heat of combustion;* SCHJÄNBERG (1936)

## METHYL FUMARATE $CH_3CO_2.CH=CH.CO_2CH_3$ *(trans)*

### Constants

*Saturated vapour pressure:* De Wolf and Van de Straete (1935)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 88.5 | 12 | 129 | 73 | 150 | 156 |
| 112 | 34 | 137 | 94 | 153 | 175 |
| 117 | 42 | | | | |

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 193°25 | Lecat (passim) | 101°7 | Viseur (1926) |
| 193°25 | Viseur (1926) | 102° | Bruni and Gorni (1900) |
| | | 102° | Sugden and Whittaker (1925) |
| | | 102° | Wasserman (1930) |

*Density*

| t° | d | |
|---|---|---|
| 105.5 | 1.0452 | De Wolf and Van de Straete (1935) |
| 110.5 | 1.0397 | „ |
| 115.95 | 1.0332 | „ |
| 110.7 | 1.0390 | Bruylants (1935) |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 106 | 25.67 | Sugden and Whittaker | 146 | 21.20 | Sugden and Whittaker |
| 123 | 23.77 | „ (1925) | 163 | 19.18 | „ (1925) |
| 132 | 22.75 | „ | | | |

*Refractive index*

| t° | $H\alpha$ | D | $H\beta$ | |
|---|---|---|---|---|
| 110.7 | 1.40367 | 1.40625 | 1.41416 | De Wolf and Van de Straete (1915) |
| 110.7 | 1.40367 | — | — | Bruylants (1935) |

## METHYL MALEATE $CH_3CO_2.CH=CH.CO_2CH_3(cis)$

### Constants

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 105.5 | 1.0567 | BRUYLANTS (1935) | 15 | 1.15557 | DE WOLF and VAN DE STRAETE (1935) |
| 109.0 | 1.0535 | „ | | | |
| 110.7 | 1.0524 | „ | 30 | 1.13952 | „ |
| 114.9 | 1.0489 | „ | | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.44107 | 1.44407 | 1.45143 | 1.45774 | DE WOLF and VAN DE STRAETE (1935) |
| 30 | 1.43506 | 1.43814 | 1.44534 | 1.45136 | „ |
| 110.7 | 1.40115 | — | — | — | BRUYLANTS (1935) |

## ETHYL FUMARATE $C_2H_5CO_2.CH=CH.CO_2C_2H_5(trans)$

### Constants

*Boiling point* *Freezing point*

| | | | |
|---|---|---|---|
| 217°85 | LECAT | 0°55 | TIMMERMANS |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 12.1 | 1.06054 | KNOPS (1888) | 20.6 | 1.05189 | PATTERSON, HENDERSON and FAIRLIE (1907) |
| 16.9 | 1.05524 | „ | | | |
| 22.0 | 1.04986 | „ | 30.23 | 1.04210 | „ |
| 26.5 | 1.04516 | „ | 33.25 | 1.03897 | „ |
| 31.8 | 1.03958 | „ | 25 | 1.0472 | WALDEN and SWINNE (1912) |

*Refractive index*

| t° | K | t° | Hα | t° | D | t° | Hβ | t° | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20.3 | 1.434206 | 20.4 | 1.437625 | 20.1 | 1.441026 | 20.1 | 1.448964 | 20.0 | 1.455968 | KNOPS (1888) |
| 24.8 | 1.432252 | 25.3 | 1.435432 | 24.4 | 1.439085 | 25.0 | 1.446789 | 24.5 | 1.453779 | „ |
| $\frac{dn}{dt}$ | 0.000434 | | 449 | | 451 | | 444 | | 486 | „ |

(For other wave-lenghts, see author)

## METHYL CITRACONATE(*cis*) METHYL MESACONATE(*trans*)

$$CH_3CO_2.CCH_3{=}CH.CO_2CH_3$$

**Constants:** Van de Straete (1935)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Boiling point:* | 210°62 (calc.) | | | | 202°83 (calc.) | | |
| *Density:* 15° | 1.12110 | | | | 1.12541 | | |
| 20° | 1.11531 | | | | — | | |
| 30° | 1.10561 | | | | 1.10914 | | |
| *Refractive index:* | 15° | 20° | 30° | $\frac{dn}{dt}$ | 15° | 30° | $\frac{dn}{dt}$ |
| Hα | 1.44752 | 1.44545 | 1.44191 | 0.00037 | 1.45378 | 1.44786 | 0.00039 |
| D | 1.45062 | 1.44856 | 1.44497 | 38 | 1.45707 | 1.45119 | 39 |
| Hβ | 1.45846 | 1.45634 | 1.45270 | 38 | 1.46616 | 1.45998 | 41 |
| Hγ | 1.46514 | 1.46312 | 1.45928 | 39 | 1.47384 | 1.46757 | 42 |

## OLEATES and ELAIDATES

$$CH_3 . (CH_2)_7 . CH{=}CH . (CH_2)_7 . CO_2R$$

**Constants**: Keffler and Mac Lean (1935); Keffler (1937)

| | | METHYL R=$CH_3$ | ETHYL R=$C_2H_5$ | *n*-PROPYL R=*n*-$C_3H_7$ | *n*-BUTYL R=*n*-$C_4H_9$ |
|---|---|---|---|---|---|
| | | *Oleate* | *Oleate* | *Oleate* | *Oleate* |
| *Density:* | 15° | 0.8774 | 0.8724 | — | — |
| | 20° | 0.8738 | 0.8687 | — | — |
| | 25° | 0.8702 | 0.8651 | — | — |
| | 30° | 0.8666 | 0.8613 | 0.8601 | 0.8599 |
| | 60° | — | — | 0.8389 | 0.8390 |
| | 90° | — | — | 0.8175 | 0.8178 |
| *Viscosity:* | 30° | 448 | 518 | 586 | 649 |
| $\eta \cdot 10_4$ | 60° | 262 | 276 | 306 | 334 |
| | 90° | 164 | 171 | 181 | 207 |
| *Heat of combustion* | *Oleates* | 9575.8 | 9629.2 | 9701.6 | 9761.5 |
| 20° ($c_v$) cal 15°/g | *Elaidates* | 9570.3 | 9632.1 | 9697.0 | 9756.7 |

# 4. OXYGENATED DERIVATIVES OF THE AROMATIC SERIES

## A. ALCOHOLS and PHENOLS

### BENZYL ALCOHOL $C_6H_5.CH_2OH$

The pure compound is synthetized by catalytic hydrogenation of benzaldehyde in the presence of platinum oxide.

**Constants:** B.E. (1935). — **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | pmm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 60.9 | 1 | 77.2 | 4 | 86.5 | 7 | 109.7 | 25 | KAHLBAUM (1894) |
| 67.8 | 2 | 80.8 | 5 | 90.7 | 9 | 115.4 | 33 | KAHLBAUM and VON WIRKNER |
| 72.9 | 3 | 83.9 | 6 | 92.6 | 10 | 124.4 | 50 | „ (1894) |
| 122.52 | 47.16 | 130.90 | 66.39 | 147.09 | 123.76 | 190.50 | 507.50 | DREISBACH and SHRADER |
| 127.12 | 57.04 | 134.28 | 75.86 | 174.64 | 315.52 | | | „ (1949) |

| *Boiling point* | | | *Melting point* | |
|---|---|---|---|---|
| 205°25 | $\frac{dt}{dp}$ *(10 mm)*: | 0°50 LECAT (passim) | −15°19 | DREISBACH and MARTIN (1949) |
| 205°35 | „ | 0°56 LOUGUININE (1898) | −15°3 | B.E. (1935) |
| 205°41 | „ | 0°4952 DREISBACH and MARTIN (1949) | −15°5 | PARKS, TODD and MOORE (1936) |
| 205°45 | „ | 0°50 B.E. (1935) | | |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| −15.3 | 1 | − 5.0 | 682 | DEFFET (1940) |
| −10.0 | 365 | 0.0 | 1010 | „ |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.06095 | B.E. (1935) | 18 | 1.0486 | HEBEISEN (1925) |
| 15 | 1.04927 | „ | 25 | 1.04127 | MARTIN and GEORGE (1933) |
| 30 | 1.03765 | „ | 0 | 1.0607 | WALDEN (1908–09) |
| 20 | 1.04535 | DREISBACH and MARTIN | 25 | 1.0415 | „ |
| 25 | 1.04156 | „ (1949) | 50 | 1.0219 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 7760 | B.E. (1935) |
| 30 | 4650 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 40.41 | B.E. (1935) |
| 20 | 29.96 | „ |
| 30 | 38.94 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.53713 | 1.53783 | 1.54260 | 1.54285 | 1.55262 | 1.55508 | 1.56272 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00040 | 40 | — | 40 | 41 | 42 | 43 | „ |
| 20 | — | — | 1.54035 | — | — | — | — | Dreisbach and Martin (1949) |
| 25 | — | — | 1.53837 | — | — | — | — | |
| $\frac{dn}{dt}$ | — | — | 0.00040 | — | — | — | — | „ |
| 25 | — | — | 1.53866 | — | — | — | — | Walden (1907) |

## Heat constants

*Specific heat:* Parks, Todd and Moore (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −183.16 | 0.1280 | −133.16 | 0.1791 | −63.16 | 0.2520 | L. −13.16 | 0.4246 |
| −173.16 | 0.1373 | −123.16 | 0.1922 | −53.16 | 0.2629 | −3.16 | 0.4325 |
| −163.16 | 0.1467 | −113.16 | 0.207 | −43.16 | 0.2740 | 6.84 | 0.4545 |
| −153.16 | 0.1561 | −103.16 | 0.228 | −33.16 | 0.294 | 16.84 | 0.4694 |
| −143.16 | 0.1673 | −73.16 | 0.2410 | | | 26.84 | 0.4843 |

| | | |
|---|---|---|
| *Heat of melting* | 19.83 cal 15 g | Parks, Todd and Moore (1936) |

### TRIPHENYLCARBINOL $(C_6H_5)_3\,COH$

*Freezing point* and *specific heat:* Smith and Andrews (1931).

### PHENYLETHYLCARBINOL $C_6H_5.CHOH.C_2H_5$

The results of Pickard and Kenyon in 1911 do not agree, neither with their values of 1914, nor with the results of Smith (1914), although the latter used Pickard's sample. Moreover the density of Smith's sample of *laevo* antipode disagrees with the density of the racemic compound prepared by another method. Pickard, Smith and Descamps (1924) show a similar disagreement for methylphenylcarbinol: $CH_3.CHOH.C_6H_5$. The values for ethylnaphthylcarbinol ($C_2H_5.CHOH.C_{10}H_7$) and for hexylnaphthylcarbinol ($C_6H_{13}.CHOH.C_{10}H_7$), published by Kenyon and Pickard (1914), and the values for phenylbenzylcarbinol ($C_6H_5.CHOH.CH_2C_6H_5$) studied by Gerrard and Kenyon (1928), must also be considered as rather dubious.

PHENYL-*n*-PROPYLCARBINOL: $C_6H_5.CHOH.n\,C_3H_7$ and 1-METHYLNAPHTHYL-CARBINOL: $CH_3.CHOH.C_{10}H_7$: *melting point*, *density* and *rotatory power*: Pickard and Kenyon (1914) and Kenyon and Partridge (1936).

## PHENOLS

### PHENOL $C_6H_5OH$

This product is purified by fractional distillation *in vacuo* and by fractional fusion. The criteria of purity are the constancy of the melting point and of the critical solution point in water for successive fractions.

**Constants:** B.E. (1937). — **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 5.4 | 0.050 | 10.2 | 0.085 | 14.7 | 0.132 | 28.5 | 0.48 | Balson (1947) |
| 6.6 | 0.055 | 11.4 | 0.095 | 22.2 | 0.272 | 32.3 | 0.667 | ,, |
| 7.8 | 0.065 | 12.5 | 0.107 | | | | | ,, |
| 44.8 | 1 | 59.4 | 4 | 67.8 | 7 | 71.8 | 9 | Kahlbaum and von Wirkner (1898) |
| 51.5 | 2 | 62.5 | 5 | 69.9 | 8 | 73.5 | 10 | |
| 55.8 | 3 | 65.3 | 6 | | | | | ,, |
| 77.7 | 13.5 | 84.3 | 18.6 | 90.9 | 25.7 | 98.3 | 37.1 | Kahlbaum (1897) |
| 79.0 | 14.1 | 84.9 | 19.1 | 91.0 | 26.1 | 99.1 | 38.7 | ,, |
| 79.3 | 14.4 | 85.0 | 19.2 | 91.4 | 26.5 | 99.4 | 39.3 | ,, |
| 80.3 | 15.1 | 85.5 | 19.7 | 91.9 | 27.2 | 99.9 | 40.1 | ,, |
| 80.5 | 15.2 | 85.7 | 19.9 | 92.4 | 28.0 | 100.6 | 41.3 | ,, |
| 81.3 | 15.8 | 86.0 | 20.2 | 92.8 | 28.8 | 101.3 | 43.0 | ,, |
| 81.4 | 15.9 | 86.1 | 20.3 | 93.3 | 29.3 | 101.5 | 43.3 | ,, |
| 81.5 | 15.9 | 86.5 | 20.5 | 93.7 | 30.1 | 102.0 | 44.4 | ,, |
| 82.1 | 16.5 | 86.7 | 21.0 | 94.0 | 30.3 | 102.6 | 45.5 | ,, |
| 82.5 | 16.6 | 87.3 | 21.8 | 94.7 | 31.2 | 102.7 | 45.9 | ,, |
| 82.6 | 16.9 | 87.4 | 22.1 | 95.4 | 32.2 | 103.6 | 47.3 | ,, |
| 82.9 | 17.1 | 88.9 | 23.3 | 96.0 | 33.2 | 103.9 | 48.1 | ,, |
| 83.5 | 18.0 | 89.1 | 23.7 | 96.7 | 34.8 | 104.4 | 49.3 | ,, |
| 83.9 | 18.1 | 89.7 | 24.1 | 96.9 | 34.9 | 104.7 | 50.0 | ,, |
| 84.1 | 18.3 | 90.3 | 24.9 | 97.5 | 35.9 | | | ,, |
| 107.15 | 57.04 | 125.95 | 123.76 | 152.37 | 315.52 | 167.63 | 507.50 | Dreisbach and Shrader (1949) |
| 113.81 | 75.86 | | | | | | | |

*Boiling point*

181°75 $\frac{dt}{dp}$ *(10 mm)*: 0°4744 Dreisbach and Martin (1949)

181°9 Dolique (1932)

182° Pardee and Weinrich (1944)

182°2 $\frac{dt}{dp}$ *(10 mm)*: 0°48 B.E. (1937) and Lecat (passim)

*Melting point*

| | | | |
|---|---|---|---|
| 40°7 | Deffet (1935) | 40°85 | Howell (1932) |
| 40°71 | Jones (1927) | 40°85 | Michel (1938) |
| 40°71 | Jones and Bury (1927) | 40°87 | Bridgman (1915) |
| 40°75 | B.E. (1937) | 40°9 | Parks, Huffman and Barmore (1933) |
| 40°8 | Friedländer (1904) | 40°90 | Dreisbach and Martin (1949) |
| 40°85 | Masse and Leroux (1916) | 40°92 | Hill and Malisoff (1926) |
| 40°85 | Dolique (1932) | 41° | Pardee and Weinrich (1944) |

Kendall asserts that the commercial product contains an impurity which raises the melting point.

*Melting curve*

| | t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|---|
| L. I | 40.70 | 1 | 50.00 | 737 | Deffet (1935) |
| | 42.60 | 155 | 52.50 | 930 | „ |
| | 45.10 | 348 | 53.00 | 971 | „ |
| | 47.50 | 540 | | | „ |
| L. I | 40.87 | 1 | L. II 62.1 | 2000 | Bridgman (1915) |
| | 47.5 | 500 | 82.1 | 3000 | „ |
| | 53.4 | 1000 | 99.8 | 4000 | „ |
| | 58.7 | 1500 | 115.9 | 5000 | „ |
| | 63.3 | 2000 | 131.0 | 6000 | „ |
| | | | 145.2 | 7000 | „ |
| L. I–II | 0.0 | 1327 | 158.8 | 8000 | „ |
| | 20.0 | 1565 | 171.9 | 9000 | „ |
| | 40.0 | 1803 | 184.6 | 10000 | „ |
| | 60.0 | 2039 | 197.0 | 11000 | „ |
| | | | 209.2 | 12000 | „ |

*Critical solution point in* $H_2O$

| | | | |
|---|---|---|---|
| 65°85 | Hill and Malisoff (1926) | 66°3–66°4 | B.E. (1937) |
| 66°06 | Friedländer (1904) | 66°5 | Dolique (1932) |

## Constants of State

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 45 | 1.05446 | B.E. (1937) | 50 | 1.0499 | Howell (1932) |
| 50 | 1.05021 | „ | 60 | 1.0413 | „ |
| 55 | 1.04604 | „ | 70 | 1.0325 | „ |
| | | | 45 | 1.0545 | Bedson and Carleton-Williams (1881) |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 45 | 407.6 | B.E. (1937) | 45 | 403.6 | THOLE (1910) |
| 60 | 257.8 | „ | 50 | 337 | DUNSTAN, HILDITCH and THOLE (1913) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 50 | 35.77 | B.E. (1937) |
| 55 | 37.26 | „ |
| 60 | 36.69 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 45 | 1.53421 | 1.53480 | 1.54027 | 1.54053 | 1.55117 | 1.55381 | 1.56225 | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00049 | 50 | — | 50 | 51 | 52 | 52 | „ |
| 40.6 | — | 1.53691 | 1.54247 | — | — | 1.55581 | 1.56840 | EISENLOHR (1911) |

The *density* and the *refractive index* of DREISBACH and MARTIN (1949) do not agree with the data of the other authors.

**Heat constants**

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −180.5 | 0.129 | −101.9 | 0.191 | −20.5 | 0.270 | PARKS, HUFFMAN and BARMORE (1933) |
| −174.5 | 0.134 | − 81.4 | 0.209 | −13.2 | 0.278 | |
| −167.1 | 0.139 | − 72.8 | 0.217 | + 3.9 | 0.306 | „ |
| −150.2 | 0.151 | − 63.9 | 0.226 | 17.1 | 0.328 | „ |
| −136.0 | 0.162 | − 36.4 | 0.252 | 22.6 | 0.338 | „ |
| −124.6 | 0.172 | | | | | „ |
| L. 90 | 0.561 | | | | | SCHLAMP (1895) |

| | | |
|---|---|---|
| *Heat of melting* | 28.67 cal 15°/g | STEINER and JOHNSTON (1928) |

## CRESOLS

Purified by alternate fractional distillation and fusion.

A very sensitive criterion of the purity of the cresols is the velocity of crystallization (MICHEL, 1938).

### *Ortho*-CRESOL $o\text{-}CH_3.C_6H_4OH$

**Constants. — Polyphasic equilibria**

*Velocity of crystallization*: 10° 20.3 cm/min MICHEL (1938)

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 36.6 | 1 | 83.7 | 14 | 96.6 | 27 | 105.2 | 40 | KAHLBAUM (1898) |
| 51.3 | 2 | 85.0 | 15 | 97.4 | 28 | 105.7 | 41 | „ |
| 57.3 | 3 | 86.3 | 16 | 98.1 | 29 | 106.3 | 42 | „ |
| 61.7 | 4 | 87.4 | 17 | 98.8 | 30 | 106.8 | 43 | „ |
| 65.5 | 5 | 88.6 | 18 | 99.5 | 31 | 107.4 | 44 | „ |
| 68.7 | 6 | 89.6 | 19 | 100.2 | 32 | 107.9 | 45 | „ |
| 71.3 | 7 | 90.6 | 20 | 100.9 | 33 | 108.4 | 46 | „ |
| 73.6 | 8 | 91.6 | 21 | 101.5 | 34 | 108.9 | 47 | „ |
| 75.7 | 9 | 92.5 | 22 | 102.2 | 35 | 109.9 | 49 | „ |
| 77.6 | 10 | 93.4 | 23 | 102.8 | 36 | 110.3 | 50 | „ |
| 79.3 | 11 | 94.3 | 24 | 103.4 | 37 | | | „ |
| 80.8 | 12 | 95.1 | 25 | 104.0 | 38 | | | „ |
| 82.3 | 13 | 95.9 | 26 | 104.6 | 39 | | | „ |
| 113.11 | 57.04 | 132.63 | 123.76 | 160.17 | 315.52 | 176.14 | 507.50 | DREISBACH and SHRADER (1949) |
| 120.22 | 75.86 | | | | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 190°95 | $\frac{dt}{dp}$ (*10 mm*): 0°4826 DREISBACH and MARTIN (1949) | 191°5 | MASSE and LEROUX (1916) |
| 191°1 | LECAT (passim) | | |

*Melting point*

| | | | |
|---|---|---|---|
| 30°35 | MICHEL (1938) | 30°5 | GLASS and MADGIN (1934) |
| 30°4 | DEFFET (1938) | 30°60 | KENDALL and BEAVER (1921) |
| 30°45 | DAWSON and MOUNTFORD (1918) | 30°8 | BRIDGMAN (1914) |
| | | 30°94 | DREISBACH and MARTIN (1949) |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| L. I 30.8 | 1 | L. II 102.7 | 6000 | BRIDGMAN (1914) |
| 47.4 | 1000 | 116.4 | 7000 | „ |
| 61.9 | 2000 | 129.3 | 8000 | „ |
| 74.2 | 3000 | 141.4 | 9000 | „ |
| 81.8 | 4000 | 153.7 | 10000 | „ |
| 94.5 | 5000 | 164.6 | 11000 | „ |
| 102.9 | 6000 | 175.9 | 12000 | „ |
| 110.8 | 7000 | | | „ |
| 118.1 | 8000 | | | „ |
| L. II 30.4 | 1 | 40.00 | 592 | DEFFET (1938–40) |
| 32.50 | 123 | 42.50 | 750 | „ |
| 35.00 | 278 | 45.50 | 943 | „ |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 25 | 1.0414 | KENDALL and BEAVER (1921) | 41 | 1.02734 | DREISBACH and MARTIN |
| | | | 46 | 1.02298 | „ (1949) |
| 25 | 1.0415 | DAWSON and MOUNTFORD (1918) | | | |

*Viscosity* $\eta \cdot 10^4$

| | | |
|---|---|---|
| 25° | 760.8 | KENDALL and BEAVER |

The *refractive index* of DAWSON and MOUNTFORD (1918) and DREISBACH and MARTIN (1949) do not agree.

## *Meta*-CRESOL $m\text{-}CH_3.C_6H_4OH$

**Constants:** B.E. (1937)

*Velocity of crystallization:* $-10°$ 10.4 cm/min MICHEL (1938)

*Boiling point*

| | | | |
|---|---|---|---|
| 202°2 | $\frac{dt}{dp}$ *(10 mm):* | 0°52 | LECAT (passim) |
| 202°2 | | | PARDEE and WEINRICH (1944) |
| 202°70 | „ | 0°52 | B.E. (1937) |

*Melting point*

| | | |
|---|---|---|
| 11°5 | PARDEE and WEINRICH (1944) | |
| 11°90 | DEFFET (1938) | |
| 11°96 | B.E. (1937) | |

*Melting curve*

| t° | p kg/cm² | |
|---|---|---|
| 11.90 | 1 | DEFFET (1938–40) |
| 17.50 | 422 | „ |
| 24.00 | 810 | „ |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.04998 | B.E. (1937) | 9 | 1.0425 | BOLLE and GUYE (1905) |
| 15 | 1.03803 | „ | 55.4 | 1.0060 | „ |
| 30 | 1.02598 | „ | 9.5 | 1.04190 | SCHWERS (1911) |
| 0 | 1.0497 | PINETTE (1888) | 20 | 1.0341 | RICHARDS and MATHEWS (1908) |

*Viscosity*

| t° | $\eta \cdot 10^4$ | |
|---|---|---|
| 15 | 2466.6 | B.E. (1937) |
| 30 | 980.7 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 38.01 | B.E. (1937) |
| 20 | 37.56 | „ |
| 30 | 36.57 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.53737 | 1.53802 | 1.54318 | 1.54344 | 1.55389 | 1.55644 | 1.56469 |
| $\frac{dn}{dt}$ | 0.00044 | 43 | — | 44 | 45 | 45 | 46 |

## *Para*-CRESOL $p\text{-}CH_3.C_6H_4OH$

### Constants

*Velocity of crystallization:* 10° 23.4 cm/min. MICHEL (1938)

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 55.7 | 1 | 94.9 | 14 | 107.8 | 27 | 115.8 | 39 | KAHLBAUM (1898) |
| 64.4 | 2 | 96.2 | 15 | 108.6 | 28 | 116.4 | 40 | „ |
| 69.4 | 3 | 97.5 | 16 | 109.2 | 29 | 117.0 | 41 | „ |
| 73.3 | 4 | 98.7 | 17 | 110.0 | 30 | 117.5 | 42 | „ |
| 76.5 | 5 | 99.8 | 18 | 110.8 | 31 | 118.0 | 43 | „ |
| 79.4 | 6 | 100.8 | 19 | 111.4 | 32 | 118.5 | 44 | „ |
| 81.9 | 7 | 101.8 | 20 | 112.1 | 33 | 119.0 | 45 | „ |
| 84.2 | 8 | 102.8 | 21 | 112.8 | 34 | 119.5 | 46 | „ |
| 86.3 | 9 | 103.7 | 22 | 113.4 | 35 | 120.0 | 47 | „ |
| 88.6 | 10 | 104.6 | 23 | 114.0 | 36 | 120.4 | 48 | „ |
| 90.1 | 11 | 105.4 | 24 | 114.6 | 37 | 120.9 | 49 | „ |
| 91.7 | 12 | 106.2 | 25 | 115.2 | 38 | 121.3 | 50 | „ |
| 93.4 | 13 | 107.0 | 26 | | | | | „ |
| 128.05 | 66.39 | 143.86 | 123.76 | 171.27 | 315.52 | 187.17 | 507.50 | DREISBACH and SHRADER (1949) |
| 131.26 | 75.86 | | | | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 201°7 | LECAT (passim) | 201°88 | $\frac{dt}{dp}$ *(10 mm):* 0°4926 DREISBACH and MARTIN (1949) |
| 201°8 | PINETTE (1888) | 202°1 | PARDEE and WEINRICH (1944) |
| | | 202°32 | GIBBS (1927) |

*Melting point*

| | | | |
|---|---|---|---|
| 34°4 | DA SILVA (1934) | 34°78 | DREISBACH and MARTIN (1949) |
| 34°55 | KENDALL and BEAVER (1921) | 34°8 | PARDEE and WEINRICH (1944) |
| 34°6 | MICHEL (1938) | | |

*Density:*

| | | |
|---|---|---|
| 25° | 1.0295 | KENDALL and BEAVER (1921) |
| 41° | 1.01788 | DREISBACH and MARTIN (1949) |
| 46° | 1.01401 | „ |

*Viscosity:* $\eta \cdot 10^4$ 25° 1474 KENDALL and BEAVER (1921)

*Refractive index:*

| | | |
|---|---|---|
| $n_D^{40°}$ | 1.5316 | PUSCHIN and MATAVULJ (1932) |
| $n_D^{41°}$ | 1.53115 | DREISBACH and MARTIN (1949) |
| $n_D^{46}$ | 1.52870 | „ |
| $\frac{dn}{dt}$ : | 0.00049 | „ |

## CARVACROL or 2-METHYL-5-*iso*-PROPYLPHENOL $CH_3.(CH_3)_2CH.C_6H_3OH$

### Constants

*Boiling point:* 237°85 LECAT (passim)

*Density*

| t° | d | |
|---|---|---|
| 18.6 | 0.9774 | BRÜHL (1899) |
| 20 | 0.9760 | „ |
| 21.4 | 0.9750 | EYKMAN (1893) |

*Refractive index*

| t° | Li | Hα | D | Tl | Hβ | Hγ | |
|---|---|---|---|---|---|---|---|
| 18.6 | 1.51926 | 1.52009 | 1.52450 | 1.52950 | 1.53581 | 1.54550 | BRÜHL (1899) |
| 21.4 | — | 1.51909 | — | — | 1.53485 | — | EYKMAN (1893) |

## THYMOL or 5-METHYL-2-*iso*-PROPYLPHENOL $CH_3.(CH_3)_2CH.C_6H_3OH$

### Constants

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 0 | 0.00046 | BALSON (1947) | 30 | 0.0300 | BALSON (1947) |
| 10 | 0.0023 | „ | 40 | 0.0953 | „ |
| 20 | 0.0087 | „ | 50 | 0.282 | „ |

*Boiling point*

| | |
|---|---|
| 232°9 | LECAT (passim) |

*Melting point*

| | |
|---|---|
| 49°6 | KENDALL (1916) |
| 49°70 | REISSERT (1890) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 51.4 | 0.9484 | SCHIFF (1884) | 9.6 | 0.9816 | EYKMAN (1893) |
| 54.9 | 0.9461 | „ | 78.5 | 0.9274 | „ |
| 64.0 | 0.9388 | „ | 80.1 | 0.9257 | „ (1919) |

*Refractive index*

| | He r. | Hα | D | He y. | He g. | Hβ | He bl. | He v | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1.49125 | 1.49184 | — | 1.49618 | 1.50474 | 150688 | 1.50919 | 1.51356 | 1.51632 | Eykman (1919) |
| | — | 1.52277 | — | — | — | 1.53865 | — | — | — | „ (1893) |
| | — | 1.49127 | — | — | — | 1.50627 | — | — | — | „ |
| | — | — | 1.5228 | — | — | — | — | — | — | Puschin and Matavulj (1932) |
| | — | — | 1.5044 | — | — | — | — | — | — | |

*Para*-THYMOL or 3-METHYL-4-*iso*-PROPYLPHENOL: $CH_3.(CH_3)_2CH.C_6H_3OH$ and *Para-iso*-PROPYLTHYMOL or 3-METHYL-4,6-DI-*iso*-PROPYLPHENOL: $CH_3[(CH_3)_2CH]_2C_6H_2OH$

*Density* and *refractive index:* Eykman (1919)

## PYROCATECHOL or *Ortho*-DIHYDROXYBENZENE $o\text{-}C_6H_4(OH)_2$

### Constants

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 245°6 | Friend and Hargreaves (1946) | 104° | Belucci and Grassi (1913) |
| | | 104°3 | Andrews, Lynn and Johnston (1926) |
| | | 105° | Friend and Hargreaves (1946) |

*Density and viscosity:* Friend and Hargreaves (1946)

| t° | d | $\eta \cdot 10^3$ | t° | d | $\eta \cdot 10^3$ | t° | d | $\eta \cdot 10^3$ |
|---|---|---|---|---|---|---|---|---|
| 121.0 | 1.1493 | 21.71 | 179.3 | 1.0902 | 8.932 | 220.6 | 1.0477 | 5.794 |
| 140.7 | 1.1297 | 15.01 | 190.0 | 1.0793 | 7.898 | 232.0 | 1.0353 | 5.152 |
| 160.0 | 1.1102 | 11.351 | 200.7 | 1.0680 | 7.024 | | | |
| 170.2 | 1.0999 | 9.954 | 210.1 | 1.0584 | 6.368 | | | |

*Specific heat*

| | | |
|---|---|---|
| L. 104°3 | 0.520 | Andrews, Lynn and Johnston (1926) |
| C. 104°3 | 0.406 | „ |
| C. 25° | 0.287 | „ |

| | | |
|---|---|---|
| *Heat of melting* | 49.40 cal 15°/g | Andrews, Lynn and Johnston (1926) |

## RESORCINOL or *Meta*-DIHYDROXYBENZENE $m\text{-}C_6H_4(OH)_2$

### Constants

*Boiling point*

| | |
|---|---|
| 275°9 | Friend and Hargreaves (1946) |

*Melting point*

| | | | |
|---|---|---|---|
| 109°7 | Andrews, Lynn and Johnston (1926) | 110°1 | Garelli (1895) |
| 110° | Friend and Hargreaves (1946) | 110°35 | Waljaschko and Schtscherbak (1925) |
| 110°1 | Schiff (1884) | | |

*Density and Viscosity:* Friend and Hargreaves (1946)

| t° | d | $\eta \cdot 10^3$ | t° | d | $\eta \cdot 10^3$ | t° | d | $\eta \cdot 10^3$ |
|---|---|---|---|---|---|---|---|---|
| 141.0 | 1.1586 | 37.55 | 220.0 | 1.0890 | 9.348 | 250.1 | 1.0624 | 6.668 |
| 159.0 | 1.1430 | 24.93 | 231.2 | 1.0792 | 8.168 | 260.0 | 1.0535 | 6.012 |
| 183.0 | 1.1217 | 14.92 | 242.0 | 1.0693 | 7.296 | | | |
| 198.3 | 1.1079 | 12.14 | | | | | | |

*Specific heat*

| | | |
|---|---|---|
| L. 109°7 | 0.522 | Andrews, Lynn and Johnston (1926) |
| C. 109°7 | 0.432 | „ |
| C. 25 | 0.284 | „ |

| | | |
|---|---|---|
| *Heat of melting* | 46.22 cal 15°/g | Andrews, Lynn and Johnston (1926) |

## QUINOL or *Para*-DIHYDROXYBENZENE $p\text{-}C_6H_4(OH)_2$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 155.0 | 5.9 | 180.7 | 26.0 | 217.7 | 105.9 | 252.4 | 315.8 | Stelzner (1901) |
| 157.6 | 7.1 | 191.1 | 40.0 | 227.6 | 147.1 | 261.3 | 403.9 | „ |
| 164.3 | 11.6 | 199.5 | 54.3 | 238.3 | 207.7 | 267.9 | 482.3 | „ |
| 173.7 | 18.2 | 210.6 | 81.5 | | | | | „ |

*Melting point:* 172°3 ANDREWS, LYNN and JOHNSTON (1926)

*Specific heat*

| | | |
|---|---|---|
| L. 172°3 | 0.562 | ANDREWS, LYNN and JOHNSTON (1926) |
| C. 172°3 | 0.422 | „ |
| C. 25 | 0.304 | „ |

| | | |
|---|---|---|
| *Heat of melting* | 58.84 cal 15°/g | ANDREWS, LYNN and JOHNSTON (1926) |

4-*n*-PROPYL PYROCATECHOL: $C_6H_3(OH)_2(n\text{-}C_3H_7)$ (1,2,4): *density* and *refractive index:* EYKMAN (1919)

For some other phenols, see PARDEE and WEINRICH (1944)

*p*-XYLOQUINOL: HO—C$\langle^{C(CH_3)-CH}_{CH=C(CH_3)}\rangle$C—OH: *Saturated vapour pressure:* COOLIDGE and COOLIDGE (1927).

## B. PHENOL ETHERS

### ANISOLE $C_6H_5OCH_3$

**Constants:** B.E. (1935)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 73.34 | 47.16 | 84.55 | 75.86 | 123.77 | 315.52 | DREISBACH and SHRADER (1949) |
| 81.31 | 66.39 | 96.89 | 123.76 | 139.37 | 507.50 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 153°75 | $\frac{dt}{dp}$ *(10 mm):* | 0°4896 | DREISBACH and MARTIN (1949) |
| 153°83 | „ | 0°47 | B.E. (1935) |
| 153°85 | | | LECAT (passim) |
| 153°9 | | | PIATTI (1930–31) |

*Melting point:* −37°7 B.E. (1935) −37°38 DREISBACH and MARTIN (1949)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.01243 | B.E. (1935) | 0 | 1.01237 | TIMMERMANS (1910) |
| 15 | 0.99858 | „ | 18 | 0.9956 | HEBEISEN (1925) |
| 30 | 0.98462 | „ | 25 | 0.98924 | MARTIN and COLLIE (1932) |
| 20 | 0.99402 | DREISBACH and MARTIN | 45 | 0.9707 | THOLE (1910) |
| 25 | 0.98932 | „ (1949) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1152 | B.E. (1935) |
| 30 | 789 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 36.18 | B.E. (1935) |
| 20 | 35.45 | „ |
| 30 | 34.15 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.51389 | 1.51478 | 1.51961 | 1.51987 | 1.52972 | 1.53235 | 1.54015 | |
| $\frac{dn}{dt}$ | 0.00049 | 50 | 50 | 50 | 51 | 51 | 52 | |
| 21 | — | — | 1.5168 | — | — | — | — | Badoche (1941) |
| 25 | — | 1.50992 | — | — | — | — | — | Martin and Collie (1932) |
| 20 | — | — | 1.51700 | — | — | — | — | Dreisbach and Martin |
| 25 | — | — | 1.51430 | — | — | — | — | „ (1949) |
| $\frac{dn}{dt}$ | — | — | 0.00054 | — | — | — | — | „ |

| *Heat of combustion* | 17°, ($c_v$) 8185.2 cal 15°/g | Badoche (1941) |
|---|---|---|

## PHENETOLE $C_6H_5 . O . C_2H_5$

**Constants:**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 91.89 | 57.04 | 98.94 | 75.86 | 139.17 | 315.52 | Dreisbach and Shrader (1949) |
| 95.60 | 66.39 | 111.56 | 123.76 | 155.16 | 507.50 | „ |

*Boiling point:* 170°00 Dreisbach and Martin (1949)
*Melting point:* −29°52 Dreisbach and Martin (1949)
−30°2 Timmermans

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.9841 | Ssachanow and Rjackowsky (1914) | 20 | 0.96514 | Dreisbach and Martin |
| | | | 25 | 0.96049 | „ (1949) |
| 15.7 | 0.9693 | Eykman (1895) | | | |
| 77.6 | 0.9110 | „ | | | |

*Viscosity*

| t° | n · $10^5$ | |
|---|---|---|
| 0 | 1883 | Ssachanow and Rjackowsky (1914) |
| 25 | 1122 | „ (1915) |

The *refractive index* of Eykman and Dreisbach do not agree.

PHENYL-*n*-PROPYL ETHER: $C_6H_5.O.n\text{-}C_3H_7$ and PHENYL-*n*-BUTYL ETHER: $C_6H_5.O.n\text{-}C_4H_9$: Friend and Hargreaves (1944).

| | | |
|---|---|---|
| PHENYL CETYL ETHER: | $C_6H_5.O.n\text{-}C_{16}H_{33}$ | Eykman (1919) |
| *Para*-THYMOL METHYL ETHER: | $CH_3.(CH_3)_2CH.C_6H_3OCH_3$ | „ |
| „ ETHYL „ : | ———— $OC_2H_5$ | „ |
| HYDROXYTHYMOL METHYL ETHER: | $CH_3.(CH_3)_2COH.C_6H_3OCH_3$ | „ |
| HYDROXY-*para*-THYMOL METHYL ETHER: | $CH_3.(CH_3)_2COH.C_6H_3OCH_3$ | „ |

## ANETHOLE or *p*-PROPENYLANISOLE *para* $CH_3.O.C_6H_4CH{=}CHCH_3$

### Constants

*Boiling point*

| | |
|---|---|
| 235°18 | Orndorff and Morton (1900) |
| 235°2 | $\frac{dt}{dp}$ *(10 mm)*: 0°58 Louguinine (1905) |
| 235°7 | Lecat (passim) |

*Melting point*

| | |
|---|---|
| 22°32 | Block (1911–12) |
| 22°3–22°5 | Grimaux (1896) |
| 22°5 | Orndorff and Morton (1900) |

*Melting curve:* Block (1913)

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 22.27 | 1 | 59.09 | 1941 | Block (1913) |
| 31.31 | 401 | 68.02 | 2480 | „ |
| 40.98 | 904 | 77.03 | 3153 | „ |
| 49.61 | 1394 | | | „ |

## VERATROLE or *o*-DIMETHOXYBENZENE *ortho*-$C_6H_4(OCH_3)_2$

### Constants

*Boiling point*

| | |
|---|---|
| 206°25 | Friend and Hargreaves (1946) |
| 206°8 | Lecat |

*Melting point*

| | | | |
|---|---|---|---|
| 22°31 | Block (1913) | 22°5 | (st. form) Deffet (1940) |
| 22°34 | „ (1911–12) | 20°9 | (unst. form) „ |
| 22°5 | Cauwood and Turner (1915) | 22°53 | Paterno (1896) |
| 22°5 | Bruni and Amadori (1910) | 22°7 | Louguinine and Dupont (1911) |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| Stab. 22.5 | 1 | Unstab. 20°9 | 1 | DEFFET (1940) |
| 25.00 | 139 | 25.00 | 248 | „ |
| 30.00 | 400 | 30.00 | 507 | „ |
| 35.00 | 665 | 35.00 | 802 | „ |
| 37.00 | 763 | | | „ |
| 39.50 | 890 | | | „ |
| Stab. 22.31 | 1 | Stab. 58.40 | 1810 | BLOCK (1913) |
| 30.65 | 343 | 67.91 | 2352 | „ |
| 40.30 | 810 | 77.31 | 2941 | „ |
| 49.05 | 1287 | | | „ |

*Density and Viscosity*

| t° | d | $\eta \cdot 10^3$ | t° | d | $\eta \cdot 10^3$ | |
|---|---|---|---|---|---|---|
| 25 | 1.0819 | — | 151.4 | 0.9523 | 4.495 | FRIEND and HARGREAVES |
| 53.2 | 1.0539 | 16.47 | 161.0 | 0.9418 | 4.131 | „ (1946) |
| 72.5 | 1.0348 | 11.63 | 171.0 | 0.9305 | 3.788 | „ |
| 92.8 | 1.0143 | 8.69 | 181.3 | 0.9186 | 3.483 | „ |
| 112.2 | 0.9943 | 6.76 | 195.1 | 0.9027 | 3.133 | „ |
| 131.0 | 0.9743 | 5.485 | | | | |

*Meta* and *Para*-DIMETHOXYBENZENE: $C_6H_4(OCH_3)_2$.
*Ortho*, *Meta* and *Para*-METHOXYPHENOL: $C_6H_4{<}^{OH}_{OCH_3}$
*Boiling* and *melting points*, *density* and *viscosity*: FRIEND and HARGREAVES (1946).

CREOSOL or 2-METHOXY-4-METHYLPHENOL: $CH_3.C_6H_3(OH).O.CH_3$
*Boiling* and *melting points*, *density* and *refractive index*: DE VRIES (1909).

## EUGENOL $CH_2{=}CH.CH_2.C_6H_3(OCH_3)OH$ (1,3,4)

**Constants**

*Boiling point:* 254°8 LECAT (passim)

*Melting point:* - 9°15 WATERMAN and PRIESTER (1929)

*Density:* 20° 1.0663 „

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.5359 | 1.5410 | 1.5543 | 1.5659 | WATERMAN and PRIESTER (1929) |

*Refractive index* (continued)

| | λ | I | II | |
|---|---|---|---|---|
| 20° | Li 6708 | 1.5349 | 1.5350 | THOMPSON (1933) |
| | Cd 6438 | 1.5366 | 1.5368 | „ |
| | D 5896 | 1.5411 | 1.5412 | „ |
| | Hg 5789 | 1.5419 | 1.5421 | „ |
| | Hg 5461 | 1.5454 | 1.5455 | „ |
| | Cd 5086 | 1.5506 | 1.5506 | „ |
| | Cd 4800 | 1.5554 | 1.5554 | „ |
| | Cd 4678 | 1.5579 | 1.5580 | „ |
| | Hg 4359 | 1.5655 | 1.5655 | „ |

METHYLEUGENOL: $CH_2=CH.CH_2.C_6H_3(OCH_3)_2$ (B.P. LECAT), EYKMAN (1895-1919)
ETHYLEUGENOL: „ $(OCH_3)(OC_2H_5)$ „
METHYL-*Iso*-EUGENOL: $CH_3.CH=CH.C_6H_3(OCH_3)_2$ (B.P. „ ) „ „
SAFROLE: $CH_2=CH.CH_2.C_6H_3.O_2.CH_2$ (B.P. „ ) „ „
*Iso*-SAFROLE: $CH_3.CH=CH.C_6H_3.O_2.CH_2$ (B.P. „ ) „ „
*Iso*-PROPYLRESORCINOL DIMETHYLETHER: $(CH_3)_2CH.C_6H_3(OCH_3)_2$ „
*Iso*-PROPENYLRESORCINOL „ : $CH_2=C(CH_3).C_6H_3(OCH_3)_2$ „

## DIPHENYL ETHER $(C_6H_5)_2O$

### Constants

*Boiling point:* 258°31 DREISBACH and MARTIN (1949)
259°0 LECAT
*Freezing point:* 26°85 DODD and HU PAK MI (1949)
26°90 DREISBACH and MARTIN (1949)
*Triple point:* 26°877 SCHWAB and WICKERS (1949)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 30 | 1.0662 | PERRAKIS (1925) | 30 | 1.06597 | DODD and HU PAK MI (1949) |
| 30 | 1.06611 | DREISBACH and MARTIN (1949) | | | |

The authors do not agree at the other temperatures.
*Viscosity:* from 31° to 35°: DODD and HU PAK MI (1949)

*Refractive index*

| t° | D | t° | D | *dn/dt* | |
|---|---|---|---|---|---|
| 30 | 1.57625 | 35 | 1.57387 | 0.00048 | DREISBACH and MARTIN (1949) |

# C. ALDEHYDES, QUINONES, KETONES

## BENZALDEHYDE $C_6H_5.CHO$

### Constants

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 50.5 | 5.1 | 64.1 | 11.1 | 72.3 | 17.4 | 81.3 | 26.9 | Kahlbaum and Wirkner |
| 51.7 | 5.5 | 64.3 | 11.6 | 72.9 | 17.6 | 81.8 | 27.5 | „ (1897) |
| 52.3 | 5.6 | 65.1 | 11.9 | 73.3 | 18.0 | 82.1 | 27.9 | „ |
| 53.5 | 6.2 | 65.3 | 12.1 | 73.7 | 18.4 | 82.4 | 28.4 | „ |
| 54.0 | 6.3 | 66.1 | 12.6 | 73.9 | 18.9 | 83.2 | 29.5 | „ |
| 55.1 | 6.7 | 66.8 | 13.1 | 74.7 | 19.5 | 83.5 | 29.9 | „ |
| 55.8 | 6.9 | 67·9 | 13.8 | 75.1 | 20.0 | 83.9 | 30.5 | „ |
| 56.5 | 7.4 | 68.8 | 14.3 | 75.5 | 20.5 | 84.7 | 31.7 | „ |
| 57.9 | 8.0 | 68.9 | 14.4 | 76.7 | 21.4 | 85.2 | 32.5 | „ |
| 59.1 | 8.6 | 69.3 | 14.7 | 77.0 | 21.9 | 85.9 | 33.5 | „ |
| 59.3 | 8.6 | 69.4 | 14.8 | 77.5 | 22.4 | 86.1 | 33.7 | „ |
| 60.5 | 9.1 | 70.3 | 15.5 | 77.8 | 22.6 | 86.6 | 34.4 | „ |
| 61.5 | 9.6 | 71.1 | 16.2 | 78.4 | 23.4 | 87.2 | 35.5 | „ |
| 61.8 | 9.7 | 71.3 | 16.2 | 78.7 | 23.7 | 87.8 | 36.4 | „ |
| 62.1 | 10.1 | 71.7 | 16.3 | 79.3 | 24.4 | 88.5 | 37.4 | „ |
| 62.4 | 10.2 | 72.1 | 16.7 | 80.2 | 25.5 | 88.6 | 37.6 | „ |
| 63.5 | 10.7 | | | 81.1 | 26.6 | 88.8 | 37.9 | „ |
| 63.7 | 10.8 | | | | | | | „ |
| 29.3 | 1 | 46.6 | 4 | 55.7 | 7 | 62.0 | 10 | Kahlbaum (1894) |
| 37.2 | 2 | 50.1 | 5 | 58.0 | 8 | 95.3 | 50 | „ |
| 42.5 | 3 | 53.0 | 6 | 60.1 | 9 | | | „ |

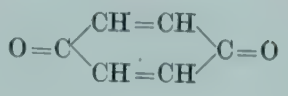
*Boiling point*

| | | |
|---|---|---|
| 178°9 | $\frac{dt}{dp}$ *(10 mm)*: 0°55 | Louguinine (1898) |
| 179°1 | | Paul and Schantz (1919) |
| 179°2 | | Lecat (passim) |

*Freezing point*

| | |
|---|---|
| −55°6 | Timmermans (passim) |
| −56°5 | Biltz, Fischer and Wunnenberg (1930) |

## *p*-BENZOQUINONE



**Constants**

*Saturated vapour pressure:*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −13.3 | 2.1 | +0.5 | 10.2 | Coolidge and Coolidge (1927) |
| −10.8 | 3.2 | 5.3 | 15.2 | ,, |

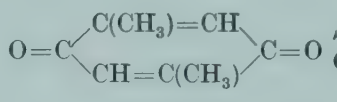
*Melting point:* 112°9 Andrews, Lynn and Johnston (1926)

*Specific heat:* cal 15°/g

| | | |
|---|---|---|
| L. 112°9 | 0.416 | Andrews, Lynn and Johnston (1926) |
| C. 112°9 | 0.399 | ,, |
| C. 25° | 0.293 | ,, |

| | |
|---|---|
| *Heat of melting* | 40.79 cal 15°/g |

*p*-XYLOQUINONE:



*Saturated vapour pressure:* see Coolidge and Coolidge (1927)

## ACETOPHENONE $C_6H_5.CO.CH_3$

Purified by fractional distillation and fusion until constancy of the melting point and of the density for successive fractions.

**Constants:** B.E. (1935). — **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 79.5 | 10.3 | 86.7 | 14.5 | 91.1 | 17.9 | 95.3 | 21.8 | Kahlbaum and Tesse (1898) |
| 80.3 | 10.6 | 87.1 | 14.9 | 91.3 | 18.2 | 95.4 | 22.0 | ,, |
| 80.6 | 10.9 | 87.2 | 15.1 | 91.7 | 18.6 | 95.6 | 22.3 | ,, |
| 81.3 | 11.3 | 88.0 | 15.5 | 92.3 | 18.9 | 96.0 | 22.5 | ,, |
| 81.9 | 11.6 | 88.4 | 15.7 | 92.9 | 19.7 | 96.5 | 23.0 | ,, |
| 82.7 | 12.0 | 89.0 | 16.3 | 93.2 | 19.7 | 96.6 | 23.2 | ,, |
| 83.8 | 12.6 | 89.2 | 16.4 | 93.4 | 20.0 | 96.9 | 23.5 | ,, |
| 84.3 | 12.9 | 89.5 | 16.6 | 94.2 | 20.5 | 97.4 | 24.0 | ,, |
| 85.0 | 13.5 | 90.3 | 17.2 | 94.5 | 21.1 | 97.7 | 24.4 | ,, |
| 85.4 | 13.8 | 90.4 | 17.3 | 95.1 | 21.6 | | | ,, |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|---|
| 98.7 | 25.4 | 103.4 | 31.2 | 107.5 | 37.4 | 111.6 | 44.4 | KAHLBAUM and TESSE (1898) |
| 99.1 | 26.0 | 103.7 | 31.6 | 107.9 | 38.0 | 111.9 | 44.8 | „ |
| 99.5 | 26.4 | 103.9 | 32.0 | 108.2 | 38.4 | 112.2 | 45.4 | „ |
| 100.0 | 26.9 | 104.5 | 32.9 | 108.7 | 39.3 | 112.7 | 46.3 | „ |
| 100.8 | 27.9 | 104.9 | 33.3 | 109.3 | 40.3 | 112.8 | 46.5 | „ |
| 101.0 | 28.0 | 105.6 | 34.4 | 109.6 | 40.8 | 113.4 | 47.6 | „ |
| 101.4 | 28.6 | 105.9 | 35.0 | 109.9 | 41.3 | 114.0 | 48.6 | „ |
| 101.5 | 28.8 | 106.6 | 35.8 | 110.3 | 42.0 | 114.5 | 49.5 | „ |
| 102.3 | 29.9 | 107.0 | 36.4 | 110.5 | 42.3 | 114.6 | 49.8 | „ |
| 103.1 | 30.9 | 107.1 | 36.8 | 111.0 | 43.3 | 114.9 | 50.4 | „ |
| 60.05 | 3.112 | 85.4 | 12.8 | 100.3 | 26.8 | | | HAM, CHURCHILL and RYDEN |
| 81.2 | 10.2 | 87.7 | 15.4 | | | | | „ (1918) |

*Boiling point*

| | |
|---|---|
| 202° | PERKIN (1896) |
| 202°0 | GRIMM and PATRICK (1923) |
| 202°0 | $\frac{dt}{dp}$ *(10 mm)*: 0°55 LECAT (passim) and B.E. (1935) |

*Melting point*

| | |
|---|---|
| 19°55 | WALDEN and BIRR (1933) |
| 19°60 | B.E. (1935) and DEFFET (1935) |
| 19°655 | MORGAN and LAMMERT (1924) |
| 20°0 | LOUGUININE and DUPONT (1911) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 19.60 | 1 | 35.00 | 736 |
| 25.05 | 266 | 40.00 | 973 |
| 30.00 | 500 | | |

*Transition curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 16.8 | 1 | 30.00 | 650 |
| 21.50 | 230 | 35.00 | 895 |
| 25.00 | 410 | 37.50 | 1015 |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 1.03236 | B.E. (1935) | 55.6 | 0.9973 | DUTOIT and FRIEDERICH |
| 20 | 1.02810 | „ | 64.4 | 0.9890 | „ (1900) |
| 30 | 1.01947 | „ | 77.1 | 0.9778 | |
| 25 | 1.02382 | MORGAN and LAMMERT (1924) | 91.9 | 0.9642 | |
| | | | 114.2 | 0.9434 | |
| 25 | 1.0237 | SUGDEN (1933) | | | |

*Density* (continued)

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 5 | 1.0408 | PERKIN (1896) | 30 | 1.0194 | PERKIN (1896) |
| 7 | 1.0390 | „ | 35 | 1.0150 | „ |
| 10 | 1.0364 | „ | 40 | 1.0106 | „ |
| 15 | 1.0320 | „ | 45 | 1.0063 | „ |
| 20 | 1.0278 | „ | 50 | 1.0021 | „ |
| 25 | 1.0236 | „ | 55 | 0.9978 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 2015 | B.E. (1935) | 30.15 | 1512.3 | GIUA and GUASTALLA |
| 30 | 1511 | „ | 34.50 | 1399.2 | „ (1933) |
| 18.70 | 1874.2 | GIUA and GUASTALLA | 37.85 | 1321.4 | „ |
| 21.30 | 1780.1 | „ (1933) | 42.30 | 1229.2 | „ |
| 25.50 | 1642 | „ | 44.50 | 1192.2 | „ |
| 28.40 | 1555 | „ | 48.10 | 1132.0 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 40.09 | B.E. (1935) |
| 20 | 39.50 | „ |
| 30 | 38.21 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.53003 | 1.53075 | 1.53631 | 1.53657 | 1.54788 | 1.55080 | 1.55993 | — | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00044 | 45 | — | 46 | 46 | 46 | 47 | — | „ |
| 20 | — | 1.52876 | 1.53423 | — | — | — | — | 1.56027 | BRÜHL (1894) |
| 20 | 1.52767 | — | — | 1.53406 | 1.54525 | — | 1.55700 | — | FEUSSNER (1927) |
| $\frac{dn}{dt}$ | 0.000457 | — | — | 462 | 473 | — | 483 | — | „ |

For other wave-lengths, see: FEUSSNER (1927)

| | | |
|---|---|---|
| *n*-BUTYL PHENYLKETONE: | $n$-$C_4H_9.CO.C_6H_5$ | YU, SHEN and WOOD (1940) |
| *n*-AMYL „ | $n$-$C_5H_{11}.CO.C_6H_5$ | „ and SIMON (1929) |
| *n*-HEXYL „ | $n$-$C_6H_{13}.CO.C_6H_5$ | YU, SHEN and WOOD (1940) and DEFFET (1931) |
| *n*-OCTYL „ | $n$-$C_8H_7.CO.C_6H_5$ | YU, SHEN and WOOD (1940) |
| *n*-UNDECYL „ | $n$-$C_{11}H_{23}.CO.C_6H_5$ | „ |
| *n*-TRIDECYL „ | $n$-$C_{13}H_{27}.CO.C_6H_5$ | „ |

## BENZOPHENONE $C_6H_5.CO.C_6H_5$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 301.9 | 701 | 305.8 | 759.7 | 306.4 | 768.5 | FINCK and WILHELM (1925) |
| 302.1 | 703.9 | 306.1 | 764.3 | 308.3 | 799.1 | „ |
| 304.1 | 732.5 | | | | | „ |
| 200.50 | 47.16 | 215.46 | 75.86 | 266.87 | 315.52 | DREISBACH and SHRADER |
| 206.42 | 57.04 | 231.57 | 123.76 | 287.23 | 507.50 | „ (1949) |
| 211.16 | 66.39 | | | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 305°82 | CALLENDAR and GRIFFITHS (1891) | 306°06 | ATEN (1912) |
| 305°84 | FINCK and WILHELM (1925) | 306°08 | $\frac{dt}{dp}$ (10 mm): 0°636 GRIFFITHS (1891) |
| 305°89 | HOLBORN and HENNING (1911) | | |
| 305°9 | DAY and SOSMAN (1912) | 306°1 | PERKIN (1896) |
| | | 306°10 | „ 0°6214 DREISBACH and MARTIN (1949) |

*Melting point*

| | | | |
|---|---|---|---|
| 48°00 | DEFFET (1935) | 48°1 | MAC NEIGHT and SMYTH (1936) |
| 48°05 | B.E. (unpublished) | 48°11 | TAMMANN (1903) |
| 48°05 | HULETT (1899) | 48°1–2 | GRINAKOWSKY (1913) |
| 48°05 | BLOCK (1911–12) | | |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|---|---|---|---|
| 48.05 | 1.033 | 51.00 | 103.3 | 53.15 | 180.775 | 55.30 | 258.250 | HULETT (1899) |
| 48.80 | 25.825 | 51.45 | 129.125 | 53.95 | 206.6 | 56.05 | 284.075 | ,, |
| 49.55 | 51.650 | 52.35 | 154.950 | 54.60 | 232.425 | 56.75 | 509.9 | ,, |
| 50.30 | 77.475 | | | | | | | ,, |
| 48.00 | 1 | 55.0 | 246 | 65.0 | 620 | 74.0 | 962 | DEFFET (1935) |
| 51.0 | 102 | 60.0 | 440 | 70.0 | 814 | 75.0 | 1000 | ,, |

*Density*

| t° | d | t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|---|---|
| 50 | 1.0846 | 65 | 1.0722 | 80 | 1.0596 | 90 | 1.0518 | PERKIN (1896) |
| 55 | 1.0805 | 70 | 1.0681 | 85 | 1.0557 | 95 | 1.0479 | ,, |
| 60 | 1.0765 | 75 | 1.0637 | | | | | ,, |

*Dielectric constant:* At different temperatures and for different frequencies, see: MAC NEIGHT and SMYTH (1936).

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_v$) 8538.1 cal 15°/g | LANDRIEU and BLATT (1924) |
| | 20° ($c_p$) 8521.6 ,, | ,, |

BENZYLIDENEACETONE: $C_6H_5.CH=CH.CO.CH_3$
STYRYLETHYLKETONE: $C_6H_5.CH=CH.CO.C_2H_5$
BENZYLIDENEPINACOLINE: $C_6H_5.CH=CH.CO.C(CH_3)_3$
} *Dsneity, refractive index* and *surface tension:* GETMAN (1910–11)

1,2-DIBENZOYLETHANE: $C_6H_5.CO.CH_2.CH_2.CO.C_6H_5$
1,2-DIBENZOYLETHYLENE: $C_6H_5.CO.CH=CH.CO.C_6H_5$
} *Heat constants:* PARKS and HUFFMAN (1930)

BENZOYLACETONE: $C_6H_5.CO.CH_2.CO.CH_3$: *Melting point, density* and *magnetic rotatory power:* PERKIN (1892).

QUINIZARIN: $C_6H_4(CO)_2C_6H_2(OH)_2$: *Saturated vapour pressure and melting point:* WENZEL and PIRAK (1934)

## D. ACIDS

### BENZOIC ACID $C_6H_5.CO_2H$

Quantitative determination of water as an impurity: SCHWAB and WICHERS (1944).

**Constants. — Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| C. 104 | 1.8 | L. 130 | 9.3 | HIRSBRUNNER (1934) |
| 110 | 2.75 | 138 | 13.8 | „ |
| 116 | 4.4 | | | „ |
| C. 60.1 | 0.0527 | L. 158.2 | 34.0 | KHOSKY, WOOD and FLANIGAN (1927) |
| 80.4 | 0.308 | 187.6 | 110.8 | „ |
| 100.2 | 1.436 | | | „ |
| 121.0 | 5.830 | | | „ |
| L. 175.5 | 71.1 | 212.7 | 262.9 | STELZNER (1901) |
| 188.6 | 114.1 | 238.9 | 570.0 | „ |
| 200.5 | 173.8 | 248.7 | 730.0 | „ |
| 207.4 | 219.8 | | | „ |

*Boiling point*

| | |
|---|---|
| 249°2 | LUMSDEN (1905) |
| 250°03 | $\frac{dt}{dp}$ *(10 mm):* 0°595 BURRIEL-MARTI (1930) |
| 250°8 | LECAT (passim) |

*Melting point*

| | |
|---|---|
| 122°305 | JESSUP and GREEN (1934) |
| 122°375 | SCHWAB and WICKERS (1945) |
| 122°43 | BURRIEL-MARTI (1930) |

*Triple point*

| | |
|---|---|
| 122°362 | SCHWAB and WICHERS (1945) |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| L. 130 | 1.07490 | BURRIEL-MARTI (1930) | C. 28 | 1.316 | JESSUP (1946) |
| 155 | 1.05218 | „ | | | |
| 180 | 1.02942 | „ | | | |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| C. −180.26 | 0.120 | −111.66 | 0.169 | −44.06 | 0.225 | PARKS, HUFFMAN and BARMORE |
| −174.46 | 0.125 | − 98.96 | 0.179 | −38.56 | 0.230 | ,, (1933) |
| −167.66 | 0.130 | − 85.16 | 0.191 | −17.06 | 0.248 | ,, |
| −151.96 | 0.141 | − 70.66 | 0.204 | + 3.44 | 0.267 | ,, |
| −137.66 | 0.151 | − 64.46 | 0.208 | 21.94 | 0.284 | ,, |
| −124.26 | 0.160 | | | | | ,, |
| | | | | | | ,, |
| L. 121°8 | 0.518 | ANDREWS, LYNN and JOHNSTON (1926) | | | | |
| C. 121°8 | 0.351 | ,, | | | | |
| C. 25° | 0.304 | ,, | | | | |

| | | | |
|---|---|---|---|
| *Heat of melting* | 121°8 | 33.89 cal 15°/g | ANDREWS, LYNN and JOHNSTON (1926) |
| *Heat of combustion* | 20°, ($c_v$) | 6319 ,, | BECKERS (1931) |
| | 25°, ($c_v$) | 6317.5 ,, | DICKINSON (1915) |
| | 25°, ($c_v$) | 6317.5 ,, | JESSUP (1942) |
| | 25°, ($c_v$) | 6317.8 ,, | JESSUP (1946) |
| | 25°, ($c_v$) | 6317.81 ,, | PROSEN and ROSSINI (1944) |

SERIJAN, HIPSHER and GIBBONS (1949) have studied the *o*, *m*, *p-tert.* butylbenzoic acids.

5-PHENYLPENTEN(3)OIC ACID: $C_6H_5.CH_2.CH{=}CH.CH_2.CO_2H$: *Density* and *refractive index:* EYKMAN (1919).

## *Ortho*-HYDROXYBENZOIC ACID (SALICYLIC ACID) $o$-$C_6H_4OH.CO_2H$

Purification and influence of water on its solubility: COHEN and VAN DOBBENBURGH (1925).

### Constants

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 182.9 | 61.8 | STELZNER (1901) | 219.8 | 260.1 | STELZNER (1901) |
| 208.6 | 171.1 | ,, | 224.1 | 301.7 | ,, |
| 214.8 | 215.1 | ,, | | | |

*Melting point*

| | |
|---|---|
| 158°3 | Crockford and Zurburg (1930) |

| | | | |
|---|---|---|---|
| *Heat of combustion* | 20° ($c_v$) | 5237.4 cal 15 g | Roth and Lasse (1924) |
| | „ „ | 5233.8 „ | Berner (1925–27) |
| | „ „ | 5237.2 „ | Verkade and Coops (1928) |
| | „ „ | 5234.9 „ | Keffler (1931) |
| | „ „ | 5237.2 „ | Beckers (1931) |
| | „ „ | 5236.4 „ | Badoche (1937) |

GALLIC ACID: $C_6H_2(OH)_3.CO_2H$; TEREPHTHALIC ACID: $p$-$C_6H_4(CO_2H)_2$: *Saturated vapour pressure:* Hirsbrunner (1934).

PHTHALIC ACID $o$-$C_6H_4(CO_2H)_2$

*Specific heat:* Parks, Todd and Moore (1936).

*Heat of combustion:* Richardson and Parks (1939); Verkade (1926) and Verkade and Hartman (unp.).

## E. ESTERS

ESTERS of METHYLBENZYLCARBINOL: $C_6H_5.CH_2.CH(CH_3).O.COR$ (R = $CH_3$ - $C_{17}H_{35}$): *Boiling point, density* and *rotatory power:* Kenyon and Pickard (1914).

*l*-PHENYLBENZYLCARBINYL ACETATE: $CH_3.CO_2.CH(C_6H_5)(CH_2.C_6H_5)$: *Density* and *rotatory power:* Gerrard and Kenyon (1928).

*m*-CRESYL ACETATE: $CH_3.CO_2.C_6H_4.CH_3$: *Saturated vapour pressure:* Balson (1947).

NAPHTYLMETHYLCARBINYL ACETATE: $CH_3.CO_2.CH(CH_3)(C_{10}H_7)$ and

ESTERS of NAPHTYLHEXYLCARBINOL: $C_{10}H_7.CH(C_6H_{13}).O.COR$ (R = $CH_3$ - $C_{10}H_{21}$): *Boiling point, density* and *rotatory power:* Kenyon and Pickard (1914).

### METHYL BENZOATE $C_6H_5.CO_2CH_3$

**Constants:** B.E. (1935)

*Saturated vapour pressure:* Kahlbaum and Tesse (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 60.6 | 4 | 100.5 | 30 | 104.1 | 35 | 107.2 | 40 |
| 64.4 | 5 | 101.3 | 31 | 104.7 | 36 | 107.8 | 41 |
| 67.7 | 6 | 102.0 | 32 | 105.4 | 37 | 108.3 | 42 |
| 77.3 | 10 | 102.8 | 33 | 106.0 | 38 | 108.9 | 43 |
| 96.3 | 25 | 103.4 | 34 | 106.6 | 39 | 112.6 | 50 |

*Boiling point*

| | |
|---|---|
| 199°2 | CRYMBLE, STEWART, WRIGHT and GLENDINNING (1911) |
| | $\frac{dt}{dp}$ (10 *mm*): 0°54 LECAT |
| 199°4 | „ 0°54 B.E. (1935) |
| 199°50 | |

*Freezing point*

| | | |
|---|---|---|
| −12°4 | (stable form) | B.E. (1935) |
| −13°9 | (unstable form) | „ |
| −12°5 | | JAEGER (1917) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| −12.10 | 1 | 5.00 | 865 |
| − 5.00 | 357 | 7.00 | 967 |
| 0.00 | 609 | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.10767 | B.E. (1935) | 4 | 1.1035 | PERKIN (1896) |
| 15 | 1.09334 | „ | 5 | 1.10259 | „ |
| 30 | 1.07901 | „ | 10 | 1.09823 | „ |
| 20 | 1.0888 | GARTENMEISTER (1890) | 15 | 1.09325 | „ |
| 25 | 1.08396 | REID (1910) | 20 | 1.08847 | „ |
| | | | 25 | 1.08772 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2298 | B.E. (1935) |
| 30 | 1673 | „ |
| 20 | 2051 | GARTENMEISTER (1890) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 38.75 | B.E. (1935) |
| 20 | 38.14 | „ |
| 30 | 36.91 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.51364 | 1.51455 | 1.51950 | 1.52963 | 1.53227 | 1.54011 |
| $\frac{dn}{dt}$ | 0.00044 | 46 | 46 | 46 | 48 | 48 |

*Magnetic rotatory power:* 11°5 1.8523 PERKIN (1896)

## ETHYL BENZOATE $C_6H_5.CO_2C_2H_5$

**Constants:** B.E. (1935)

*Boiling point*

| | | | |
|---|---|---|---|
| 212°40 | $\frac{dt}{dp}$ *(10 mm)*: | 0°57 | B.E. (1935) |
| 212°45 | „ | 0°54 | KURBATOW (1903) |
| 212°5 | „ | 0°57 | LECAT (passim) |

*Freezing point*: —34°7 B.E. (1935)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.06498 | B.E. (1935) | 12.5 | 1.0535 | KREMAN, MEINGAST and GUGL (1914) |
| 15 | 1.05112 | „ | | | |
| 30 | 1.03718 | „ | 24.3 | 1.0426 | „ |
| 4 | 1.0614 | PERKIN (1896) | 26.3 | 1.0407 | „ |
| 5 | 1.06049 | „ | 33.2 | 1.0346 | „ |
| 10 | 1.05591 | „ | 46.8 | 1.0222 | „ |
| 15 | 1.05138 | „ | 56.8 | 1.0130 | „ |
| 20 | 1.04684 | „ | 57.5 | 1.0125 | „ |
| 25 | 1.04214 | „ | 67.1 | 1.00360 | „ |
| 15 | 1.0509 | LUMSDEN (1905) | 69 | 1.0016 | „ |
| 15 | 1.0510 | MATSUNO and HAN (1933) | | | |
| 25 | 1.0417 | REID (1910) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2407 | B.E. (1935) |
| 30 | 1751 | „ |
| 11 | 2705 | KREMANN, MEINGAST and GUGL (1914) |
| 12 | 2566 | „ |
| 64 | 751 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 35.94 | B.E. (1935) |
| 20 | 35.31 | „ |
| 30 | 34.12 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.50226 | 1.50291 | 1.50748 | 1.50774 | 1.51704 | 1.51926 | 1.52672 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00039 | 39 | — | 41 | 41 | 41 | 42 | „ |
| 20 | — | — | 1.50570 | — | — | — | — | DUMMER (1919) |

*Magnetic rotatory power:* 12°9 1.7533 PERKIN (1896)

*Iso*-BUTYL BENZOATE: $C_6H_5.CO_2\,CH_2.CH\,(CH_3)_2$: *Boiling point:* LECAT; *density* and *magnetic rotatory power:* PERKIN (1896).

*d-sec*-BUTYL, HEXYL, OCTYL, NONYL, UNDECYL BENZOATES: $C_6H_5.CO_2R$ ($R=C_4H_9$, $C_6H_{13}$-, $C_8H_{17}$-, $C_9H_{19}$-, $C_{11}H_{23}$-*sec*): *Boiling point, density, refractive index* and *rotatory power:* KENYON and PICKARD (1915)

BENZYLMETHYLCARBINYL BENZOATE: $C_6H_5CO_2CH(CH_2C_6H_5)(CH_3)$: *Boiling point, density, refractive, index* and *rotatory power:* KENYON and PICKARD (1915).

*Sec.* β-OCTYL ESTERS of *o, m, p*-TOLUIC ACIDS: *o, m, p*-$CH_3C_6H_4.CO_2\,C_8H_{17}$: *Boiling point* and *density:* RULE, HAY, NUMBERS and PATERSON (1928).

## ETHYL CINNAMATE $C_6H_5.CH=CH.CO_2C_2H_5$

### Constants

*Boiling point*

| | | *Melting point* | |
|---|---|---|---|
| 271°0 | WEGER (1883) | 6°70 | WALDEN and SWINNE (1912) |
| 272°0 | LECAT | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 12.9 | 1.05560 | PERKIN (1892) | 16.8 | 1.0519 | AUWERS (1917) |
| 91.1 | 0.98815 | „ | 20.0 | 1.0490 | BRÜHL (1886–96–97) |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 16.8 | 1.55355 | 1.56118 | 1.58223 | 1.60250 | AUWERS (1917) |
| 20 | — | 1.5597 | — | — | „ |
| 12.9 | 1.55508 | 1.56351 | 1.58466 | — | PERKIN (1892) |
| 91.1 | 1.51797 | 1.52500 | 1.54422 | — | „ |
| 20 | 1.55216 | 1.55982 | 1.58043 | 1.60053 | BRÜHL (1896–97) |

*n*-PROPYL PHENYLCINNAMATE: $C_6H_5CH=C(C_6H_5)CO_2n\text{-}C_3H_7$; METHYL *allo*-CINNAMYL ACRYLATE: $C_6H_5CH=CH.CH=CH.CO_2CH_3$: *Density, refractive index:* EYKMAN (1919).

NAPHTHOIC ESTERS $C_{10}H_7CO_2R$

*sec.*-BUTYL; HEXYL; HEPTYL; OCTYL; NONYL; DECYL; UNDECYL NAPHTHOATES: (R = *sec.*-$C_4H_9$; $C_6H_{13}$; $C_7H_{15}$; $C_8H_{17}$; $C_9H_{19}$; $C_{10}H_{21}$; $C_{11}H_{23}$); BENZYLMETHYLCARBINYL NAPHTHOATE: (R = $C_6H_5.CH_2.CH(CH_3)$: *Boiling point, density, refractive index* and *rotatory power:* KENYON and PICKARD (1915).

## DIETHYL PHTHALATE $C_6H_5(CO_2C_2H_5)_2$

**Constants:** B.E. (unp.)

*Boiling point:* 289°5 BRÜHL (1894)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.13592 | B.E. (unp.) | 14.3 | 1.1232 | BRÜHL (1894) |
| 15 | 1.12276 | „ | 17.8 | 1.1202 | AUWERS and SCHMIDT (1913) |
| 30 | 1.10958 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 15934 | B.E. (unp.) |
| 30 | 8742 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 38.01 | B.E. (unp.) | 20.5 | 37.34 | HARKINS, BROWN and DAVIES (1917) |
| 20 | 37.41 | „ | | | |
| 30 | 36.39 | „ | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 14.3 | — | 1.50070 | 1.50490 | — | — | — | 1.52498 | BRÜHL (1894) |
| 15 | 1.49937 | 1.49993 | — | 1.50431 | 1.51269 | 1.51483 | — | B.E. (unp.) |
| $\frac{dn}{dt}$ | 0.00041 | 41 | — | 41 | 42 | 43 | — | „ |
| 17.7 | — | 1.49890 | 1.50293 | — | — | 1.51356 | 1.52284 | AUWERS and SCHMIDT (1917) |

METHYL, ETHYL and *n*-PROPYL MANDELATES: $C_6H_5.CHOH.CO_2R$ (R = $CH_3$, $C_2H_5$, *n*-$C_3H_7$): *Boiling point, density* and *rotatory power:* WALKER (1909).

*sec.*-OCTYL *o,m,p*-METHOXYBENZOATES *o,m,p*-$CH_3O.C_6H_4.CO_2$-*sec.*-$C_8H_{17}$. *Density* and *rotatory power:* RULE and NUMBERS (1926).

## METHYL SALICYLATE $o\text{-}C_6H_4OH.CO_2CH_3$

### Constants

*Saturated vapour pressure:* RAMSAY and YOUNG (1887)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 175 | 215 | 185 | 287.8 | 195 | 378.9 | 205 | 491.7 | 215 | 630.15 |
| 176 | 221.65 | 186 | 296.0 | 196 | 389.15 | 206 | 504.35 | 216 | 645.55 |
| 177 | 228.3 | 187 | 304.45 | 197 | 399.6 | 207 | 517.25 | 217 | 661.25 |
| 178 | 235.15 | 188 | 313.05 | 198 | 410.3 | 208 | 530.4 | 218 | 677.25 |
| 179 | 242.15 | 189 | 321.85 | 200 | 421.2 | 209 | 543.8 | 219 | 693.6 |
| 180 | 249.35 | 190 | 330.85 | 201 | 432.35 | 210 | 557.5 | 220 | 710.2 |
| 181 | 256.7 | 191 | 340.05 | 202 | 443.75 | 211 | 571.45 | 221 | 727.05 |
| 182 | 264.2 | 192 | 349.45 | 203 | 455.35 | 212 | 585.7 | 222 | 744.35 |
| 183 | 271.9 | 193 | 359.05 | 204 | 467.25 | 213 | 600.25 | 223 | 761.9 |
| 184 | 279.75 | 194 | 368.85 | 205 | 479.35 | 214 | 615.05 | 224 | 779.85 |

*Boiling point*

| | |
|---|---|
| 222°88 | GRIFFITHS (1891) $\frac{dt}{dp}$ *(10 mm):* 0°57 |
| 222°9 | RAMSAY and YOUNG (1887) |
| 222°95 | LECAT |
| 223°03 | CALLENDAR and GRIFFITHS (1891) |

*Freezing point:* —8°6 TIMMERMANS

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 4 | 1.1992 | PERKIN (1896) | 15 | 1.1881 | PERKIN (1896) |
| 5 | 1.1981 | „ | 20 | 1.1834 | „ |
| 10 | 1.1930 | „ | 25 | 1.1788 | „ |

*Magnetic rotatory power:* 15°8 2.0071 PERKIN (1896)

## PHENYL SALICYLATE or SALOL $o\text{-}C_6H_4OH.CO_2C_6H_5$

*Melting point*

| | | | |
|---|---|---|---|
| 41°2 | Francis and Collins (1936) | 41°7 | Deffet (1935) |
| 41°38 | Campetti (1912–1913) | 42°5 | Miers and Isaac (1907) |

*Melting curve:* Deffet (1935)

| *Stable form* | | *Unstable form II* | | *Unstable form V* | |
|---|---|---|---|---|---|
| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
| 41.70 | 1 | 38.8 | 1 | (12.9) | 1 |
| 50.00 | 315 | 40.00 | 49 | 17.50 | 192 |
| 55.00 | 508 | 45.00 | 245 | 20.00 | 296 |
| 60.00 | 702 | 50.00 | 423 | 22.50 | 400 |
| 65.00 | 898 | 55.00 | 426 | 25.00 | 505 |
| 67.00 | 975 | 60.00 | 830 | 30.00 | 706 |
| | | | | 33.00 | 827 |
| | | | | 35.00 | 910 |
| | | | | 36.60 | 980 |

*Density*

| t° | d | |
|---|---|---|
| 45 | 1.17858 | Burriel-Marti (1930) |
| 55 | 1.16981 | „ |
| 75 | 1.1526 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 45 | 746.0 | Burriel-Marti (1930) |
| 60 | 482.3 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 45 | 41.53 | Burriel-Marti (1930) |
| 60 | 38.86 | „ |

ETHYL METHYLSALICYLATE: $C_6H_4\begin{matrix}OCH_3\\CO_2C_2H_5\end{matrix}$ : *Boiling point, density and magnetic rotatory power:* Perkin (1896)

DIMETHYL and DIETHYL MONOBENZOYLTARTRATES: $(RCO_2)_2.CHOCOC_6H_5.CHOH$ (R = $CH_3$; $C_2H_5$) *Melting point, density and rotatory power:* Wood and Nicholas (1928)

DIMETHYL and DIETHYL DIBENZOYLTARTRATES: $(RCO_2.CHOCOC_6H_5)_2$. „

## 5. OXYGENATED DERIVATIVES OF POLYMETHYLENES

### *Cyclo*-PENTANOL $C_5H_9OH$

This compound is prepared by hydrogenation of cyclopentanone with platinum blak as a catalyst.

**Constants:** B.E. (1937)

*Boiling point*

| | |
|---|---|
| 140°85 | $\frac{dt}{dp}$ *(10 mm):* 0°41 B.E. (1937) and LECAT (passim) |

*Freezing point:* —19°0

*Density*

| t° | d |
|---|---|
| 0 | 0.96253 |
| 15 | 0.95078 |
| 30 | 0.93908 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 14080 |
| 30 | 7596 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 33.60 |
| 20 | 33.07 |
| 30 | 32.12 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 15 | 1.45252 | 1.45286 | 1.45512 | 1.45529 | 1.45974 | 1.46090 | 1.46148 |
| $\frac{dn}{dt}$ | 0.00046 | 46 | — | 47 | 47 | 47 | 47 |

### 1-METHYL-*cyclo*-PENTANOL-1 $CH_3.C_5H_8OH$

Prepared by GRIGNARD'S synthesis from cyclopentanone and methylmagnesium bromide. It decomposes on boiling (dehydration).

**Constants:** B.E. (1937)

*Freezing point:* 35°50

*Density*

| t° | d | t° | d |
|---|---|---|---|
| 36 | 0.90652 | 45 | 0.89747 |
| 40 | 0.90253 | 50 | 0.89251 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 36 | 6731 |
| 45 | 4585 |

*Surface tension*

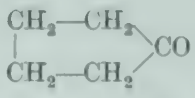
| t° | $\gamma$ |
|---|---|
| 36 | 28.19 |
| 40 | 27.80 |
| 45 | 27.22 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 40 | 1.43855 | 1.43871 | 1.44125 | 1.44547 | 1.44649 | 1.44981 |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 49 | 47 | 45 | 48 |

DIALKYL-*cyclo*-PENTANOLS 1: $C_5H_7OH(R_2)[(R)_2=(CH_3)_2;\ (C_2H_5)_2;\ (CH_3,\ n\text{-}C_3H_7)]$: *Melting point, density, viscosity* and *refractive index:* CHIURDOGLU (1933–34–35).

## *Cyclo*-PENTANONE



Cyclopentanone is prepared by condensation of adipic acid by means of baryta.

**Constants:** B.E. (1937)

*Boiling point*

| | | |
|---|---|---|
| 130°65 | $\frac{dt}{dp}$ | *(10 mm):* 0°48 B.E. (1935) and LECAT |

*Freezing point:* —51°3

*Density*

| t° | d |
|---|---|
| 0 | 0.96800 |
| 15 | 0.95353 |
| 30 | 0.93902 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 2253 |
| 30 | 995 |

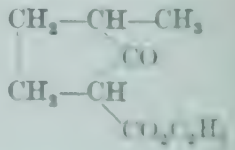
*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 34.37 |
| 20 | 33.87 |
| 30 | 32.58 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.43645 | 1.43679 | 1.43934 | 1.44379 | 1.44498 | 1.44845 |
| $\frac{dn}{dt}$ | 0.00042 | 40 | 42 | 42 | 42 | 42 |

METHYL-*cyclo*-PENTANONE ETHYL CARBOXYLATE



**Constants:** CHIURDOGLU (1935)

*Boiling point:* 111°0/16 mm; 109°5/15 mm

*Density:* 0° 1.06386; 20° 1.04516 *Viscosity* $\eta \cdot 10^5$: 15° 5103; 30° 3407

*Refractive index:* 20° Hα: 1.44430; He y.: 1.44667; Hβ: 1.45242; Hγ: 1.45697

## *Cyclo*-HEXANOL $C_6H_{11}OH$

Prepared from pure phenol by catalytic hydrogenation (platinum) and purified by distillation under reduced pressure until constancy of the melting point and of the density for successive fractions.

**Constants:** B.E. (1937)

*Boiling point* — *Melting point*

| | | | |
|---|---|---|---|
| 160°8 | $\frac{dt}{dp}$ *(10 mm):* 0°45 LECAT | 25°15 | B.E. (1937) |
| | | 25°45 | DEFFET (1940) |
| 161°10 | „ 0°45 B.E. (1937) | 25°46 | LANGE (1932) |
| 161°3 | NAGORNOW and ROTINJANZ (1911) | | |

*Melting curve*

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 25.45 | 1 | DEFFET (1940) | 50.00 | 685 | DEFFET (1940) |
| 30.00 | 133 | „ | 60.00 | 968 | „ |
| 40.00 | 400 | „ | | | |

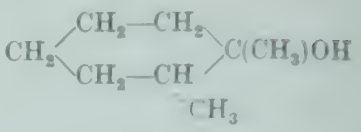
*Density* — *Viscosity* — *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 30 | 0.94155 | 30 | 41067 | 25.5 | 33.91 | B.E. (1937) |
| 45 | 0.92994 | 45 | 17194 | 30 | 33.47 | „ |
| | | | | 40 | 32.24 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 25 | 1.46201 | 1.46246 | 1.46477 | 1.46494 | 1.46947 | 1.47063 | 1.47422 |
| $\frac{dn}{dt}$ | 0.00038 | 38 | — | 38 | 38 | 39 | 40 |

1,2-DIMETHYL-*cyclo*-HEXANOL-1



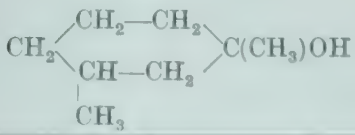
**Constants:** CHIURDOGLU (1938)

| | | *Trans* | | | *Cis* | | |
|---|---|---|---|---|---|---|---|
| *Boiling point*/25mm | | 74°0 | | | 82°85 | | |
| *Freezing point* | | 13°2 | | | 23°2 | | |
| *Density:* | 15° | 0.92346 | | | — | | |
| | 20° | 0.91874 | | | 0.92504 | | |
| | 30° | 0.90940 | | | 0.91692 | | |
| | 40° | 0.90000 | | | 0.90882 | | |
| *Viscosity:* | 15° | 24520 | | | — | | |
| $\eta \cdot 10^5$ | 20° | 17258 | | | — | | |
| | 30° | 9143 | | | 25424 | | |
| | 40° | 5466 | | | 13500 | | |
| *Refractive index* | | 20° | 30° | $\frac{dn}{dt}$ | 20° | 30° | $\frac{dn}{dt}$ |
| | Hα | 1.45903 | 1.45416 | 0.00049 | 1.46252 | 1.45826 | 0.00043 |
| | He y. | 1.46145 | 1.45650 | 49 | 1.46494 | 1.46059 | 43 |
| | Hβ | 1.46712 | 1.46211 | 50 | 1.47058 | 1.46617 | 44 |
| | Hγ | 1.47176 | 1.46669 | 51 | 1.47530 | 1.47083 | 45 |

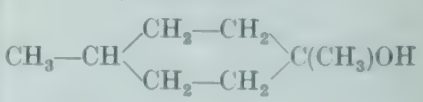
Other DIMETHYL-*cyclo*-HEXANOLS-1

**Constants:** CHIURDOGLU (1938)

1,3-DIMETHYL



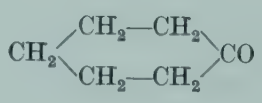
1,4-DIMETHYL



| | *Trans* | *Cis* | *Cis* |
|---|---|---|---|
| *Boiling point* /25 mm | 77°55 | 84°0 | 83°75 |
| *Freezing point* | 14°5 | 27°5 | 24° |
| *Density* | 0° 0.91366 | 30° 0.90216 | 30° 0.90112 |
| | 15° 0.91052 | 40° 0.89358 | 40° 0.89290 |
| | 20° 0.89748 | 45° 0.88930 | 45° 0.88880 |
| | 30° 0.88936 | 50° 0.88502 | |
| | 40° 0.88124 | | |
| *Viscosity:* | 15° 41898 | 30° 19774 | 30° 21740 |
| $\eta \cdot 10^5$ | 20° 28421 | 40° 10881 | 40° 11567 |
| | 30° 14009 | 45° 8331 | 45° 8828 |
| | 40° 7649 | 50° 6534 | |

| | 1,3-DIMETHYL-*cyclo*-HEXANOL-1 | | | | 1,4-DIMETHYL-*cyclo*-HEXANOL-1 | |
|---|---|---|---|---|---|---|
| | *Trans* | | *Cis* | | *Cis* | |
| *Refractive index:* 20° | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ | | $\frac{dn}{dt}$ |
| Hα | 1.45073 | — | 1.45753 | — | 1.45643 | — |
| He y. | 1.45317 | — | 1.45996 | — | 1.45887 | — |
| Hβ | 1.45880 | — | 1.46564 | — | 1.46455 | — |
| Hγ | 1.46347 | — | 1.47029 | — | 1.46920 | — |
| 30° | | | | | | |
| Hα | 1.44651 | 0.00042 | 1.45304 | 0.00045 | 1.45213 | 0.00043 |
| He y. | 1.44897 | 42 | 1.45547 | 45 | 1.45457 | 43 |
| Hβ | 1.45462 | 42 | 1.46108 | 45 | 1.46029 | 43 |
| Hγ | 1.45923 | 42 | 1.46575 | 45 | 1.46486 | 43 |

## *Cyclo*-HEXANONE



**Constants:** B.E. (1937)

*Boiling point*

| | | |
|---|---|---|
| 155°65 | $\frac{dt}{dp}$ *(10 mm):* 0°48 | |
| 155°7 | „ 0°48 Lecat | |

*Freezing point*

| | |
|---|---|
| −31°2 | Timmermans |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.96435 | B.E. (1937) | 20 | 0.9462 | Allsopp (1934) |
| 15 | 0.95099 | „ | 20 | 0.9466 | Richards and Shipley (1916) |
| 30 | 0.93761 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 2453 | B.E. (1937) | 17.3 | 2300 | Herz and Bloch (1924) |
| 30 | 1803 | „ | 39.1 | 1549 | „ |
| | | | 65.9 | 1012 | „ |

*Surface tension*

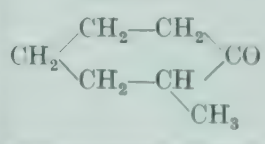
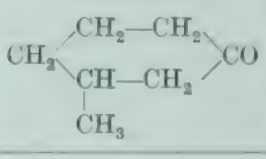
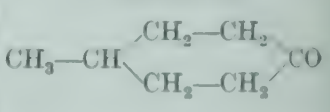
| t° | $\gamma$ | |
|---|---|---|
| 15 | 35.12 | B.E. (1937) |
| 20 | 34.50 | „ |
| 30 | 33.51 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.44922 | 1.44956 | 1.45203 | 1.45220 | 1.45696 | 1.45818 | 1.46176 | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00036 | 36 | — | 37 | 37 | 38 | 38 | „ |
| 19.3 | — | — | 1.45066 | — | — | — | — | Herz and Bloch (1924) |

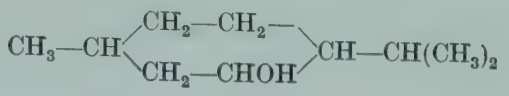
## METHYL-*cyclo*-HEXANONES

**Constants:** Chiurdoglu (1938)

| | | 2-METHYL  | 3-METHYL  | 4-METHYL  |
|---|---|---|---|---|
| *Boiling point* | | 165°08 | 169°58 | 171°25 |
| *Freezing point* Timmermans (passim) | | −14° | −73°5 | −40°6 |
| *Density:* | 0° | 0.94238 | 0.93214 | 0.93241 |
| | 15° | 0.92933 | 0.91954 | 0.91984 |
| | 20° | 7.92500 | 0.91535 | 0.91562 |
| | 30° | 0.91632 | 0.90694 | 0.90728 |
| *Viscosity:* $\eta \cdot 10^5$ | 15° | 1845 | 1999 | 1916 |
| | 30° | 1406 | 1512 | 1457 |
| *Refractive index:* 20° | | | | |
| | Hα | 1.44571 | 1.44360 | 1.44290 |
| | He y. | 1.44817 | 1.44606 | 1.44536 |
| | Hβ | 1.45392 | 1.45182 | 1.45112 |
| | Hγ | 1.45873 | 1.45658 | 1.45588 |

3-METHYL-*cyclo*-HEXANONE: *Rotatory dispersion in the ketonic absorption bands* Lowry, Simpsons and Allsopp (1937)

MENTHOL (*l* and *d*)



## Constants

*Boiling point:* 216°3 LECAT

*Melting point*

| | | | |
|---|---|---|---|
| 42°45 | HULETT (1899) | 42°5 | ADAMANIS (1933) |
| 42°5 | WRIGHT (1917) | 43° | PICKARD and LITTLEBURY (1912) |

*Melting curve*

| *Form I* | | *Form II* | | |
|---|---|---|---|---|
| t° | p kg/cm² | t° | p kg/cm² | |
| 42.45 | 1 | 36.40 | 1 | HULETT (1899) |
| 43.00 | 25 | 36.90 | 25 | „ |
| 43.75 | 50 | 37.60 | 50 | „ |
| 44.35 | 75 | 38.30 | 75 | „ |
| 44.85 | 100 | 38.90 | 100 | „ |
| 45.55 | 125 | 39.40 | 125 | „ |
| 46.20 | 150 | 40.05 | 150 | „ |
| 46.80 | 175 | 40.75 | 175 | „ |
| 47.25 | 200 | 41.35 | 200 | „ |
| 47.90 | 225 | 41.95 | 225 | „ |
| 48.60 | 250 | 42.60 | 250 | „ |
| 49.25 | 275 | 43.15 | 275 | „ |
| 49.80 | 300 | 43.70 | 300 | „ |

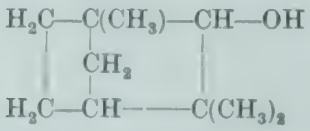
*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 40.9 | 0.8839 | Patterson and Taylor | 80 | 0.8534 | Kenyon and Pickard |
| 59 | 0.8699 | „ (1905) | 100 | 0.8379 | „ (1915) |
| 80 | 0.8534 | „ | 120 | 0.8223 | „ |
| 20 | 0.9007 | Kenyon and Pickard | 140 | 0.8070 | „ |
| 40 | 0.8848 | „ (1905) | 160 | 0.7917 | „ |
| 60 | 0.8690 | „ | 180 | 0.7760 | „ |

*Rotatory power*

| t° | (α) D | | t° | (α) D | |
|---|---|---|---|---|---|
| 35.2 | 49.73 | Patterson and Taylor | 63.2 | 49.95 | Patterson and Taylor |
| 39.5 | 49.82 | „ (1905) | 70.2 | 49.90 | „ (1905) |
| 43.0 | 49.88 | „ | 78.0 | 49.82 | „ |
| 48.2 | 49.89 | „ | 100 | 49.51 | „ |
| 53.5 | 49.94 | „ | 40 | 49.55 | Kenyon and Pickard |
| 58.3 | 49.96 | „ | | | (1915) |

## FENCHYL ALCOHOL (*l* and *d*)

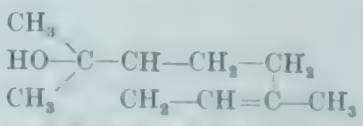


*Melting point:* 42°1 Fischer (1939)
41°5 Deffet (1940)

*Melting curve:* Deffet (1940)

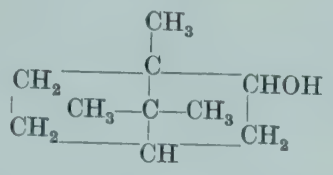
| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 41.5 | 1 | | 60.6 | 796 | |
| 48.0 | 282 | | 63.6 | 940 | |
| 55.0 | 584 | | | | |

## TERPINEOL and esters.



*Density, refractive index, rotatory power:* Fuller and Kenyon (1924).
*Boiling point:* Terpineol α: 218°85; Terpineol β: 210°5 Lecat.

## BORNEOL



**Constants:** VANSTONE (1910–1909)

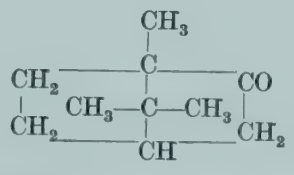
*Saturated vapour pressure*

| *Stat. meth.* | | *Dynam. meth.* | |
|---|---|---|---|
| t° | p mm | t° | p mm |
| 78.0 | 2.30 | 77.9 | 2.16 |
| 95.1 | 6.67 | 96.8 | 6.55 |
| 110.5 | 15.70 | 110.0 | 15.00 |
| 130.2 | 40.4 | 131.0 | 40.92 |
| 150.2 | 96.6 | 156.6 | 115.16 |
| 158.4 | 127.2 | | |

*Boiling point:* 215°0
215°0 LECAT

*Melting point:* 208°6

## CAMPHOR



**Constants**

*Saturated vapour pressure:* DE WILDE (1937)

| | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|
| C. | 65.14 | 3.9 | 105.14 | 27.3 | 140.84 | 108.4 | 168.24 | 272.7 |
| | 69.84 | 6.1 | 109.24 | 31.7 | 146.54 | 127.8 | 168.94 | 274.2 |
| | 75.54 | 8.0 | 110.34 | 32.7 | 150.84 | 152.3 | 171.14 | 295.1 |
| | 79.94 | 8.9 | 115.54 | 41.6 | 152.94 | 165.6 | 173.44 | 318.4 |
| | 85.14 | 10.5 | 117.04 | 42.8 | 155.84 | 182.1 | 173.74 | 321.1 |
| | 88.84 | 14.0 | 120.54 | 50.5 | 157.14 | 190.0 | 176.24 | 346.2 |
| | 92.94 | 15.9 | 125.74 | 61.6 | 158.04 | 196.2 | 177.64 | 359.7 |
| | 95.14 | 17.0 | 129.74 | 71.9 | 160.94 | 216.8 | 178.54 | 368.1 |
| | 100.04 | 21.9 | 130.94 | 74.5 | 163.14 | 231.6 | 179.44 | 379.3 |
| | 102.54 | 23.9 | 136.14 | 89.8 | 165.94 | 252.6 | 180.34 | 390.0 |
| | 103.24 | 25.7 | | | | | | |
| L. | 178.04 | 368.1 | 186.34 | 456.1 | 198.74 | 619.5 | 215.64 | 920.3 |
| | 179.14 | 379.3 | 188.54 | 481.6 | 201.74 | 664.8 | 220.84 | 1027.9 |
| | 180.14 | 390.0 | 191.54 | 514.1 | 203.94 | 699.2 | 225.44 | 1143.4 |
| | 181.14 | 398.4 | 191.64 | 517.0 | 206.74 | 749.1 | 225.84 | 1150.4 |
| | 182.24 | 408.3 | 193.54 | 544.1 | 211.04 | 817.8 | 232.34 | 1290.8 |
| | 183.24 | 419.5 | 195.74 | 587.6 | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 207·42 | DE WILDE (1937) | 209·1 | LECAT |

*Freezing point*

| | | | |
|---|---|---|---|
| 178°43 | FRANSDEN (1931) | 178°8 *(rac)* | LOUGUININE (1889) |
| 178°5 *(d)* | FISCHER (1939) | 178°8 | FAUCON (1912) |
| 178°6 *(d)* | ROOS and SOMERVILLE (1926) | 179°5 | DE WILDE (1937) |
| 178°6 | HALLER (1892) (from BANGPHIËN) | | |

*Triple point:* 180°1/385.8 mm. DE WILDE (1937)

*Rotatory power:* 15°–16° $(\alpha)D$: ± 42.76 HALLER (1892
180°, between 5893 and 2485 Å, see diag. LOWRY and GORE (1932)

| | | |
|---|---|---|
| *Heat of melting* | 10.74 cal 15°/g | FRANSDEN (1931) |

METHOXYMETHYLENE CAMPHOR: $C_{12}H_{18}O_2$: *Density* and *refractive index:* BRÜHL (1894).

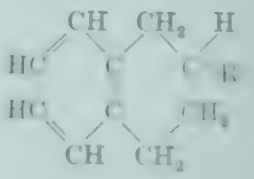
PULEGONE: $C_{10}H_{16}O$
*Boiling point:* 223°8 LECAT; *refractive index, rotatory power:* LOWRY, SIMPSONS and ALLSOPP (1937).

*d*-CARVONE: $(CH_3)C_6H_6O\,C(CH_3)—CH_2$; DIHYDROCARVONE: $(CH_3)C_6H_8OC(CH_3)—CH_2$;
DIHYDROEUCARVONE: $CH_3—CH\begin{matrix}CO—CH_2—C(CH_3)_2\\ CH_2—CH=CH\end{matrix}$

and CARVENONE: $CH_3—C_6H_6O—CH(CH_3)_2$

*Boiling point:* LECAT; *density, refractive index:* BRÜHL (1899) and HERNQUIST (1914).

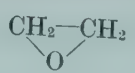
ESTERS of *l*- and *d*-TETRAHYDRO-2-NAPHTHOL:
R = $CH_3CO_2$; $C_2H_5CO_2$; $C_4H_9CO_2$; *n*-$C_{11}H_{23}CO_2$: KENYON and PICKARD (1912–14).



METHYL-*cyclo*-PROPANE-1,1-DICARBOXYLATES and homologues:
$(CH_2)_2C(CO_2CH_3)_2$: *Density, refractive index, rotatory power* VOGEL (1944).

# 6. HETEROCYCLIC OXYGEN COMPOUNDS

## EPOXYETHANE or ETHYLENE OXIDE



**Constants:** B.E. (1937)

*Satured vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −49.372 | 33.94 | −21.847 | 175.58 | +0.194 | 497.41 | Giauque and Gordon |
| −43.311 | 50.70 | −16.956 | 225.28 | 5.644 | 625.07 | „ (1949) |
| −38.242 | 69.68 | −14.825 | 250.14 | 9.210 | 721.95 | „ |
| −33.273 | 93.73 | − 9.828 | 317.68 | 11.934 | 804.01 | „ |
| −28.169 | 124.93 | − 4.904 | 397.77 | | | „ |

*Boiling point*

| | | |
|---|---|---|
| 10°50 | $\frac{dt}{dp}$ *(10 mm)*: 0°40 | Giauque and Gordon (1949) |
| 10°7 | | B.E. (1937) |
| 10°75 | | Lecat |

*Freezing point*

| | |
|---|---|
| −111°7 | B.E. (1937) |
| −112°51 | Giauque and Gordon (1949) |

*Density:* (with dilatometer) 0° 0.89713 5° 0.89057

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 0 | 309 | B.E. (1937) |
| 5 | 295 | „ |
| 10 | 283 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 0.1 | 28.00 | B.E. (1937) |
| 4.9 | 27.24 | „ |
| 10 | 26.39 | „ |

*Specific heat:* Giauque and Gordon (1949) (M.W. 44.052)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| −257.83 | 0.015 | −164.74 | 0.271 | −76.37 | 0.440 | (other temperatures, |
| −247.71 | 0.0549 | −151.66 | 0.292 | −64.31 | 0.443 | see authors) |
| −237.03 | 0.101 | −132.52 | 0.331 | −52.49 | 0.444 | |
| −224.33 | 0.149 | −126.97 | 0.348 | −39.96 | 0.447 | |
| −214.92 | 0.179 | −121.76 | 0.365 | −32.59 | 0.450 | |
| −205.45 | 0.204 | L. −107.19 | 0.447 | −19.67 | 0.455 | |
| −195.03 | 0.224 | −101.14 | 0.445 | − 7.55 | 0.461 | |
| −183.69 | 0.243 | − 89.45 | 0.444 | + 2.52 | 0.467 | |
| | | | | 10.77 | 0.470 | |

*Heat of vaporisation:* 138.5 cal 15°/g Giauque and Gordon (1949)
*Heat of melting:* 28.066 „ „

## PARALDEHYDE $(CH_3CHO)_3$

This compound is purified by crystallization. For the equilibria with acetaldehyde and the "natural constants" of this system of dynamic isomers, see: HOLLMANN (1903).

### Constants

*Critical temperature:* 290° HOLLMANN (1903)

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 123°87 | HOLLMANN (1903) | 12°5 | COOPER (1926–27) |
| 123°93 | COFFETTI (1903) | 12°55 | HOLLMANN (1903) |
| 124°35 | LECAT and FRIEND and HARGREAVES (1944) | 12°6 | LOUGUININE and DUPONT (1911) |
| | | 12°61 | TURBABA (1901) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 12 | 1.00058 | PASCAL and DUPUY (1920) | 60.1 | 0.9454 | FRIEND and HARGREAVES |
| 20 | 0.9933 | „ | 70.0 | 0.9342 | „ (1944) |
| 40 | 0.9673 | „ | 79.2 | 0.9233 | „ |
| 15.0 | 0.9962 | FRIEND and HARGREAVES | 91.2 | 0.9088 | „ |
| 42.6 | 0.9654 | „ (1944) | | | |
| 51.3 | 0.9558 | „ | | | |

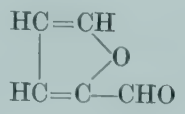
*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 10 | 1527 | DRUCKER and KASSEL | 60.1 | 595.7 | FRIEND and HARGREAVES |
| 76.5 | 478 | „ (1911) | 70.0 | 520.6 | „ (1944) |
| 20 | 1178 | MUCHIN (1913) | 79.2 | 464.2 | „ |
| 15.0 | 1324 | FRIEND and HARGREAVES | 91.2 | 401.8 | „ |
| 42.6 | 775 | „ (1944) | 103.9 | 349.5 | „ |
| 51.3 | 674.7 | „ | 117.2 | 302.7 | „ |

*Surface tension:* 5° 27.82 SCHIFF (1884)

| | | | |
|---|---|---|---|
| *Magnetic rotatory power* | 17°3 | 0.9058 | PERKIN (1884) |

# FURFURAL



## Constants

*Saturated vapour pressure:* Evans and Aylesworth (1926)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 39.9 | 8 | 131.6 | 310 | 159.0 | 707 | 163.8 | 812 |
| 92.3 | 69 | 140.2 | 411 | 160.9 | 744 | 170.6 | 966 |
| 120.3 | 214 | 154.4 | 625 | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 161°45 | Lecat | 161°7 | Evans and Aylesworth (1926) |
| 161°7 | Mains (1922) | 161°9 | von Reis (1881) |

*Critical solution point in* $H_2O$: 120°9 Evans and Aylesworth (1926)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.1808 | Walden (1906) | 20 | 1.1598 | Mains (1922) |
| 25 | 1.1544 | „ | 25 | 1.1545 | „ |
| 0 | 1.1811 | Walden (1908–09) | 25 | 1.1546 | Walden (1907) |
| 25 | 1.1544 | „ | | | |
| 50 | 1.1284 | „ | | | |

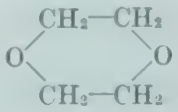
*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 0 | 2475 | Walden (1906) |
| 25 | 1494 | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.51862 | 1.52608 | 1.54566 | 1.56484 | Brühl (1886) |
| 20 | — | 1.52608 | — | — | Evans and Aylesworth (1926) |
| 25 | — | 1.52345 | — | — | Walden (1907) |

## DIOXAN



It is impossible to purify dioxan by simple fractional distillation: this operation must be alternated with fractional fusion. In addition an isomerisation to acetal takes place: this transformation leads to an equilibrium system, containing 3 % of acetal, melting at 10°2. Furthermore, an enantiotropic modification exists, having a transition point of −0°1 (Deffet, 1935).

Rosendahl (1946) studied the critical constants, the saturated vapour pressure, the viscosity and the surface tension; he does not entirely agree with us, although his melting point is 11°75–11°80.

**Constants**: B.E. (1937).

*Boiling point*

| | | | |
|---|---|---|---|
| 101°320 | $\frac{dt}{dp}$ *(10 mm)*: | 0°432 | Wojciechowski and Smith (1937) |
| 101°35 | „ | 0°43 | Lecat |
| 101°40 | „ | 0°43 | B.E. (1937) |
| 101°43 | | | Teague and Felsing (1943) |
| 101°50 | | | Pesce and Lago (1944) |

*Melting point*

| | | | |
|---|---|---|---|
| 11°65 | Pesce and Lago (1944) | 11°8 | Teague and Felsing (1943) |
| 11°7 | Schütz (1938) | 11°80 | B.E. (1937) |
| 11°76 | Harned and Morrison (1936) | 11°80 | Ewert (1937) |
| 11°78 | Rosendahl (1946) | 11°80 | Hess and Frahm (1938) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 1.03922 | B.E. (1937) | 25 | 1.0276 | Schneider and Lynch (1943) |
| 20 | 1.03361 | „ | | | |
| 30 | 1.02230 | „ | 25 | 1.0280 | Teague and Felsing (1943) |
| 20 | 1.03364 | Schütz (1938) | | | |
| 20 | 1.03375 | Hess and Frahm (1938) | 25 | 1.02802 | Pesce and Lago (1944) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1439 | B.E. (1937) |
| 30 | 1087 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 34.45 | B.E. (1937) |
| 20 | 33.74 | „ |
| 30 | 32.20 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42198 | 1.42225 | 1.42436 | 1.42456 | 1.42865 | 1.42958 | 1.43290 | — | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00042 | 42 | — | 43 | 43 | 43 | 44 | — | „ |
| 20 | — | — | 1.42241 | — | — | — | — | — | Hess and Frahm (1938) |
| 25 | — | — | 1.4201 | — | — | — | — | — | Schneider and Lynch (1943) |
| 25 | — | — | 1.4202 | — | — | — | — | — | Teague and Felsing (1943) |
| 25 | — | — | 1.4202 | — | — | — | — | — | Few and Smith (1949 |
| 25 | — | — | 1.42025 | — | — | — | — | — | Frey and Gilbert (1937) |

## MALEIC ANHYDRIDE $(CHCO)_2O$

### Constants

*Saturated vapour pressure:* Winstrom and Kulp (1949)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 35.0 | 0.36 | 50.0 | 1.90 | 52.8 | 2.24 | 60.0 | 3.39 |
| 40.0 | 0.69 | 51.0 | 1.99 | 54.0 | 2.34 | 65.0 | 4.43 |
| 45.0 | 1.22 | 52.0 | 2.16 | 55.0 | 2.53 | 70.0 | 5.93 |

*Boiling point:* 200° Perkin (1888)

*Melting point:* 52°6 Weiss and Downs (1923)
52°8 Winstrom and Kulp (1949)

# 7. SUGARS

## α-*d*-GALACTOSE $C_6H_{12}O_6$

*Rotatory power:* $(\alpha)_D^{20}$ : 80.0 (Final) JACK and STEGEMAN (1941)

*Specific heat:* JACK and STEGEMAN (1941) (M.W. 180.156)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −209.24 | 0.06284 | −140.00 | 0.1357 | −78.08 | 0.1941 | −9.28 | 0.2584 |
| −199.13 | 0.07450 | −130.76 | 0.1448 | −68.34 | 0.2027 | −0.62 | 0.2687 |
| −179.30 | 0.09670 | −120.75 | 0.1541 | −59.38 | 0.2115 | + 7.21 | 0.2744 |
| −169.68 | 0.1066 | −111.83 | 0.1619 | −38.45 | 0.2287 | 15.12 | 0.2790 |
| −159.98 | 0.1165 | −103.71 | 0.1695 | −29.47 | 0.2370 | 23.70 | 0.2926 |
| −149.08 | 0.1265 | − 87.39 | 0.1827 | −17.38 | 0.2483 | | |

## *l*-SORBOSE $C_6H_{12}O_6$

*Rotatory power:* $(\alpha)_D^{20}$ −43°1 (Final) CLARKE and STEGEMAN (1939)

*Specific heat:* JACK and STEGEMAN (1941) (M.W. 180.156)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −209.14 | 0.06372 | −131.87 | 0.1520 | −70.89 | 0.2191 | −15.69 | 0.2655 |
| −190.77 | 0.08487 | −121.57 | 0.1636 | −59.20 | 0.2237 | − 5.12 | 0.2764 |
| −168.12 | 0.1096 | −113.06 | 0.1735 | −48.72 | 0.2351 | +10.86 | 0.2893 |
| −148.99 | 0.1304 | −102.21 | 0.1891 | −37.98 | 0.2440 | 19.69 | 0.2984 |
| −140.80 | 0.1403 | − 90.46 | 0.2075 | −27.48 | 0.2527 | | |

## SACCHAROSE $C_{12}H_{22}O_{11}$

Purified by crystallization from absolute alcohol *in vacuo* (DICKINSON, 1915 and VOSBURGH, 1921). For criteria of purity, see: "*Publications of the Institute of pure Reagents of Moscow*".

| | | |
|---|---|---|
| *Heat of combustion* | 20°, $(c_v)$ 3943 cal 15°/g | KARRER and FIORONI (1923) |
| | 15°–20°, $(c_v)$ 3943 „ | SWIETOSLAWSKI and STARCZEWSKA (1922) |
| | 20°, $(c_v)$ 3943 „ | DICKINSON (1915) |

## α-LACTOSE MONOHYDRATE $C_{12}H_{22}O_{11}.H_2O$

*Rotatory power:* $(\alpha)\ ^{20^\circ}_{D}$ 55.°0 (Final) CLARKE and STEGEMAN (1939)

*Specific heat:* ANDERSON and STEGEMAN (1941) (M.W. 360.314)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −208.01 | 0.06558 | −132.31 | 0.1447 | −60.75 | 0.2115 | −11.44 | 0.2589 |
| −198.16 | 0.07690 | −109.12 | 0.1663 | −50.77 | 0.2218 | + 1.17 | 0.2696 |
| −191.42 | 0.08429 | − 92.55 | 0.1817 | −41.47 | 0.2294 | 11.05 | 0.2796 |
| −181.43 | 0.09613 | − 77.77 | 0.1960 | −34.04 | 0.2372 | 20.19 | 0.2889 |
| −169.42 | 0.1072 | − 69.01 | 0.2045 | −20.24 | 0.2516 | 24.26 | 0.2916 |
| −150.93 | 0.1265 | | | | | | |

## β-LACTOSE $C_{12}H_{22}O_{11}$

*Rotatory power:* $(\alpha)\ ^{20^\circ}_{D}$ 55°0 (Final) CLARKE and STEGEMAN (1939)

*Specific heat:* ANDERSON and STEGEMAN (1941) (M.W. 342.298)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −200.27 | 0.07312 | −134.34 | 0.1394 | −71.92 | 0.1970 | −10.40 | 0.2540 |
| −185.32 | 0.08933 | −123.84 | 0.1486 | −55.54 | 0.2151 | − 2.23 | 0.2618 |
| −168.65 | 0.1058 | −108.30 | 0.1644 | −37.87 | 0.2297 | + 7.05 | 0.2714 |
| −158.84 | 0.1156 | − 90.11 | 0.1789 | −20.30 | 0.2469 | 16.28 | 0.2791 |
| −143.18 | 0.1303 | − 82.69 | 0.1860 | | | | |

## β-MALTOSE MONOHYDRATE $C_{12}H_{22}O_{11}.H_2O$

*Rotatory power:* $(\alpha)\ ^{20^\circ}_{D}$ 131°0 (Final) CLARKE and STEGEMAN (1939)

*Specific heat:* ANDERSON and STEGEMAN (1941) (M.W. 360.314)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −212.05 | 0.06086 | −151.49 | 0.1285 | −79.08 | 0.1968 | −30.96 | 0.2451 |
| −202.76 | 0.07116 | −140.16 | 0.1387 | −71.17 | 0.2054 | −14.02 | 0.2637 |
| −191.03 | 0.08566 | −125.23 | 0.1549 | −61.47 | 0.2163 | − 1.13 | 0.2744 |
| −181.93 | 0.09608 | −108.21 | 0.1714 | −49.72 | 0.2279 | 10.42 | 0.2852 |
| −169.69 | 0.1094 | −100.11 | 0.1785 | −37.91 | 0.2399 | 23.11 | 0.2990 |
| −159.80 | 0.1189 | − 89.68 | 0.1886 | | | | |

# 8. MIXED OXYHALOGENATED DERIVATIVES

## CARBONYL CHLORIDE or PHOSGENE $COCl_2$

**Constants:** GIAUQUE and JONES (1948)

*Boiling point:* 7°56

*Melting point:* −127°86

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −57.619 | 24.75 | −32.132 | 122.12 | −0.953 | 541.28 |
| −51.651 | 37.32 | −25.527 | 173.88 | +3.948 | 660.07 |
| −45.783 | 54.67 | −17.778 | 255.50 | 8.003 | 773.12 |
| −39.357 | 80.75 | − 9.087 | 381.88 | | |

*Density:* DAVIES (1946)

| t° | d | t° | d | t° | d |
|---|---|---|---|---|---|
| 0.00 | 1.4187 | 14.50 | 1.3853 | 27.00 | 1.3547 |
| 5.00 | 1.4076 | 20.00 | 1.3714 | 37.00 | 1.3310 |

$dt_4 = 1.42014 - 0.0023120\ t° - 0.000002872\ t^{-2}$ DAVIES (1946)

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.30 | 0.0164 | −202.59 | 0.1139 | L. −124.78 | 0.2526 | −61.24 | 0.2403 |
| −257.12 | 0.0197 | −196.06 | 0.1187 | −120.42 | 0.2508 | −55.36 | 0.2403 |
| −255.34 | 0.0272 | −190.19 | 0.1225 | −115.65 | 0.2491 | −49.00 | 0.2404 |
| −252.67 | 0.0363 | −184.04 | 0.1262 | −110.10 | 0.2472 | −36.20 | 0.2412 |
| −249.11 | 0.0463 | −177.36 | 0.1306 | −103.76 | 0.2459 | −22.99 | 0.2420 |
| −244.82 | 0.0569 | −171.20 | 0.1341 | − 97.36 | 0.2447 | −10.34 | 0.2426 |
| −240.16 | 0.0681 | −164.62 | 0.1383 | − 91.09 | 0.2441 | +6.30 | 0.2429 |
| −235.09 | 0.0781 | −158.21 | 0.1428 | − 84.90 | 0.2425 | | |
| −229.80 | 0.0856 | −151.67 | 0.1458 | − 78.21 | 0.2414 | | |
| −224.62 | 0.0924 | −146.19 | 0.1499 | − 72.16 | 0.2405 | | |
| −219.35 | 0.0990 | −140.19 | 0.1517 | − 66.00 | 0.2400 | | |
| −214.51 | 0.1037 | −136.45 | 0.1556 | | | | |
| −209.12 | 0.1084 | −132.42 | 0.1606 | | | | |

| | |
|---|---|
| *Heat of vaporisation* | (B.P) 58.96 cal 15°/g |
| *Heat of melting* | 13.86 „ |

## ETHYLENE CHLOROHYDRIN $CH_2Cl.CH_2OH$

## (2-CHLOROETHYL ALCOHOL)

This compound gives with water an azeotrope, boiling at 97°8, with 45.8 % of chlorohydrin according to PALHAVOUNI (1927); 42.5 % according to GOMBERG (1919), or 41 % according to BANCELIN and RIVAT (1919).

**Constants:** B.E. (1928)

*Boiling point:* 128°6 $\frac{dt}{dp}$ *(10 mm):* 0°40 B.E. (1928) and LECAT

*Freezing point:* −67°5

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.22310 | B.E. (1928) | 20 | 1.2022 | MATHEWS (1926) |
| 15 | 1.20720 | „ | | | |
| 20 | 1.20190 | „ | | | |
| 30 | 1.19118 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 3913 | B.E. (1928) |
| 30 | 2688 | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.44148 | 1.44380 | 1.44946 | 1.45414 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00039 | 39 | 38 | 37 | „ |
| 20 | — | 1.44208 | — | — | MATHEWS (1926) |

| | | |
|---|---|---|
| *Heat of vaporisation* | (126°55) 122.97 cal 15°/g | MATHEWS (1926) |

| | 2-FLUOROETHYL ALCOHOL $CH_2F.CH_2OH$ | | | | 2,2-DIFLUOROETHYL ALCOHOL $CHF_2.CH_2OH$ | | | |
|---|---|---|---|---|---|---|---|---|
| **Constants:** SWARTS (1923–27–31) | | | | | | | | |
| *Density* | | 18°3 | 1.1143 | | | 17°2 | 1.3084 | |
| *Viscosity:* $\eta \cdot 10^5$ | 20° | 1924 | 50° | 1044 | 20° | 2650 | 50° | 1275 |
| | 30° | 1540 | 60° | 889 | 30° | 2030 | 60° | 1042 |
| | 40° | 1247 | | | 40° | 1580 | | |
| *Refractive index* | | | | | | | | |
| Hα | | 18°3 | 1.3622 | | | 17°2 | 1.33290 | |
| Hβ | | | 1.3684 | | | | 1.33729 | |
| Hγ | | | 1.3714 | | | | 1.34148 | |

| | TRIFLUOROALKYL ALCOHOLS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $CF_3.CH_2OH$ | | $\begin{matrix}CH_3\\CF_3\end{matrix}\!\!>\!\!CHOH$ | | $\begin{matrix}CH_3\\CF_3\end{matrix}\!\!>\!\!CH.CH_2OH$ | | | |
| **Constants:** SWARTS (1927–29–31–34) | | | | | | | | |
| *Boiling point* | 74°05 | | 77°95 | | 81°60 | | | |
| *Melting point* | −43°5 | | — | | −20°75 | | | |
| *Density* | 0° | 1.4106 | 15° | 1.2799 | 22°6 | 1.1903 | | |
| | 22° | 1.3736 | | | | | | |
| *Viscosity:* $\eta \cdot 10^5$ | 20° | 1995 | 15° | 3685 | 25° | 3328 | 3320 | |
| | 30° | 1543 | 24°92 | 2586 | 30° | 2706 | 2706 | |
| | 40° | 1216 | 35° | 1772 | 35° | 2240 | 2240 | |
| | 60° | 796 | 44°95 | 1301 | 40° | 1836 | 1845 | |
| | | | 55° | 994 | 45° | 1591 | 1590 | |
| | | | | | SWARTS | (1927) | (1931) | |
| *Refractive index* | | | | | | | | |
| Hα | 22° | 1.2896 | 15° | 1.31610 | 22°6 | 1.33120 | | |
| D | | 1.2907 | | 1.31720 | | 1.33241 | | |
| Hβ | | 1.2934 | | 1.32120 | | 1.33619 | | |
| Hγ | | — | | 1.32253 | | 1.33804 | | |

DICHLOROETHYL ETHER: $C_4H_8Cl_2O$: *Boiling* and *melting point*, *density*: TSCHAMLER (1948).

## DIFLUOROACETIC ACID $CHF_2.CO_2H$

**Constants**: SWARTS (1919-23-31)

*Boiling point:* 134°2

*Melting point:* 40°35

*Density:* 20°1 1.52546

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|
| 20 | 2982 | 50 | 1550 |
| 30 | 2332 | 60 | 1296 |
| 40 | 1904 | | |

*Refractive index* 20° Hα 1.34044; D 1.34195; Hβ 1.34553; Hγ 1.34812

## TRIFLUOROACETIC ACID $CF_3.CO_2H$

**Constants**: SWARTS (1922–31)

72°4–72°5

−15°25

0° 1.53515

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|
| 19.75 | 876 | 50.35 | 569 |
| 30.05 | 750 | 60.4 | 502 |
| 39.92 | 653 | 65.42 | 473 |

## MONOCHLOROACETIC ACID $CH_2Cl.CO_2H$

**Constants**

*Boiling point:* 189°35 LECAT

*Melting point*

| | | | |
|---|---|---|---|
| α 62°3 | GRINAKOWSKI (1913) | β 56°3 | MICHEL (1938) |
| „ 62°45 | HULETT (1899) | γ 50°65 | „ |
| „ 62°80 | MICHEL (1938) | | |
| „ 63° | RABINOWITSCH (1926) | | |
| „ 63° | SUDBOROUGH and LLOYD (1899) | | |

*Melting curve:* HULETT (1899)

| | t° | atm. | t° | atm. | t° | atm. | t° | atm. |
|---|---|---|---|---|---|---|---|---|
| Form α | 62.45 | 1 | 64.40 | 100 | 65.85 | 175 | 67.10 | 250 |
| | 62.90 | 25 | 64.90 | 125 | 66.30 | 200 | 67.60 | 275 |
| | 63.40 | 50 | 65.40 | 150 | 66.70 | 225 | 68.10 | 300 |
| | 63.90 | 75 | | | | | | |

*Density* *Surface tension*

| t° | d | t° | d | t° | γ | |
|---|---|---|---|---|---|---|
| 39.75 | 1.4043 | 60°80 | 1.3734 | 48.8 | 33.74 | GRINAKOWSKI (1913) |
| 49.30 | 1.3884 | 79°30 | 1.3518 | 58.8 | 32.66 | „ |
| | | | | 70.10 | 31.56 | „ |

MONOBROMO and MONOIODO ACETIC ACIDS: $CH_2Br.CO_2H$ and $CH_2I.CO_2H$:
*Melting point, density* and *surface tension:* JASPER and ROSENSTEIN (1942).

## β-CHLOROCROTONIC ACID β-CHLORO *iso*-CROTONIC ACID

$CH_3.CCl.CH.CO_2H$

**Constants:** SKAU and SAXTON (1928)

| *Melting point* | 93°6 | 60°5 |
|---|---|---|
| *Specific heat* | C. (93°6) 0.327<br>L. „ 0.413 | C. (60°5) 0.303<br>L. „ 0.395 |
| *Heat of melting* | 41.080 cal 15°/g | 27.387 cal 15°/g |

ACETYL and *n*-PROPIONYL CHLORIDES: $CH_3COCl$ and $C_2H_5COCl$:
*Boiling point, density* and *viscosity:* FRIEND and HARGREAVES (1946).

## *n*-CAPROYL CHLORIDE *n*-$C_5H_{11}.COCl$

**Constants:** SIMON (1929)

*Boiling point:* 152°60 *Freezing point:* −87°3

*Density*

| t° | d |
|---|---|
| 0 | 0.99541 |
| 15 | 0.98047 |
| 30 | 0.96540 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.42593 | 1.42615 | 1.42859 | 1.42877 | 1.43341 | 1.43467 | 1.43824 | 1.43981 |
| 25 | 1.42148 | 1.42181 | 1.42424 | 1.42435 | 1.42896 | 1.43024 | 1.43377 | 1.43505 |
| $\frac{dt}{dn}$ | 0.00044 | 44 | 43 | 44 | 44 | 44 | 45 | 47 |

| | ACID-CHLORIDES | | | |
|---|---|---|---|---|
| | *n*-OENANTHOYL $C_6H_{13}COCl$ | *n*-CAPRYLOYL $C_7H_{15}COCl$ | *n*-PELARGOYL $C_8H_{17}COCl$ | *n*-CAPRINOYL $C_9H_{19}COCl$ |
| **Constants:** DEFFET (1931) | | | | |
| *Boiling point* | 175°2 | 195°55 | 215°35 | 232°3 |
| *Freezing point* | −83°8 | −61°0 | −60°5 | −34°5 |
| *Density:* 0° | 0.98079 | 0.96707 | 0.95901 | — |
| 15° | 0.96645 | 0.95349 | 0.94633 | — |
| 30° | 0.95219 | 0.94000 | 0.93353 | — |
| *Viscosity:* $\eta \cdot 10^5$ | | | | |
| 15° | 1210 | 1564 | 1913 | — |
| 30° | 977 | 1216 | 1447 | — |
| *Refractive index:* 15° | | | | |
| | $\frac{dn}{dt} \cdot 10^5$ | $\frac{dn}{dt} \cdot 10^5$ | $\frac{dn}{dt} \cdot 10^5$ | |
| He r. | 1.43032 44 | 1.43344 43 | 1.43766 38 | — |
| Hα | 1.43077 44 | 1.43408 42 | 1.43802 38 | — |
| He y. | 1.43329 44 | 1.43648 43 | 1.44054 39 | — |
| He g. | 1.43794 44 | 1.44127 42 | 1.44530 38 | — |
| Hβ | 1.43907 44 | 1.44245 42 | 1.44647 38 | — |
| He v. | 1.44236 44 | 1.44583 43 | 1.44977 39 | — |
| Hγ | 1.44372 44 | 1.44730 — | 1.45111 39 | — |

## SUCCINOYL CHLORIDE $COCl.CH_2.CH_2.COCl$

**Constants:** FRIEND and HARGREAVES (1946)

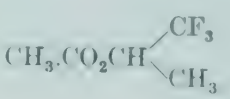
*Melting point:* 16°7

*Density and viscosity*

| t° | d | $\eta \cdot 10^3$ | t° | d | $\eta \cdot 10^3$ |
|---|---|---|---|---|---|
| 20.3 | 1.3771 | 25.27 | 100.8 | 1.2783 | 7.656 |
| 41.55 | 1.3507 | 16.75 | 119.2 | 1.2552 | 6.313 |
| 52.0 | 1.3375 | 14.23 | 139.1 | 1.2300 | 5.224 |
| 61.65 | 1.3257 | 12.45 | 159.7 | 1.2035 | 4.365 |
| 71.6 | 1.3141 | 10.89 | 170.0 | 1.1900 | 4.018 |
| 82.8 | 1.3002 | 9.45 | | | |

| | FLUOROETHYL ACETATES | | |
|---|---|---|---|
| | MONO $CH_3.CO_2.CH_2.CH_2F$ | DI $CH_3.CO_2.CH_2.CHF_2$ | TRI $CH_3.CO_2.CH_2.CF_3$ |
| **Constants:** SWARTS (1919-23-31-34) | | | |
| *Boiling point* | 119°55 | 106°4 | 77°8 |
| *Density* | 20° 1.0982<br>20°2 1.0982 | 13° 1.1958<br>15° 1.1781 | 20° 1.2426 |
| *Viscosity:* $\eta \cdot 10^5$ | | | |
| 20° | 1086 | 1130 | 698 |
| 30° | 927 | 953 | 604.9 |
| 40° | 796 | 816 | 528.4 |
| 50° | 697 | (49°9) 703 | 465.3 |
| 60° | 618 | 613 | — |
| *Refractive index:* 15° | | | |
| Hα | 1.37545 | 1.35294 | 1.31884 |
| D | 1.37792 | — | 1.32020 |
| Hβ | 1.38212 | 1.35847 | 1.3233 |
| Hγ | 1.38533 | 1.36154 | — |

## TRIFLUORO-*iso*-PROPYL ACETATE



**Constants:** SWARTS (1929–31)

*Boiling point:* 85°6/75 mm *Density:* 15° 1.1823

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|
| 19.85 | 725.5 | 50.15 | 478 |
| 30.05 | 623.2 | 60 | 425.4 |
| 39.95 | 544.7 | | |

*Refractive index*

| t | Hα | D | Hβ | Hγ |
|---|---|---|---|---|
| 15 | 1.33021 | 1.3314 | 1.33520 | 1.33806 |

| | ETHYL FLUOROACETATES | | |
|---|---|---|---|
| | MONO $CH_2F.CO_2C_2H_5$ | DI $CHF_2.CO_2C_2H_5$ | TRI $CF_3.CO_2C_2H_5$ |
| **Constants:** SWARTS (1919–23–31–34) | | | |
| *Boiling point* | 121°7 | 99°4 | — |
| *Density* | 20°5 1.0926 | 9°8 1.18933<br>17° 1.1800 | 16°7 1.19529 |
| *Viscosity:* $\eta \cdot 10^5$ | | | |
| 20° | 958.0 | 761.2 | 434.2 |
| 30° | 817.6 | 661.6 | 384.8 |
| 40° | 707.8 | 580.5 | 344.9 |
| 50° | 619.1 | 515.7 | 312 |
| 60° | 553 | 459.7 | (60°15) 282 |
| *Refractive index* | 20°5 | 9°8 | 16°7 |
| Hα | 1.37494 | 1.34888 | 1.30783 |
| D | 1.37665 | — | — |
| Hβ | 1.38075 | 1.35324 | 1.31237 |
| Hγ | 1.38413 | — | 1.31527 |

## TRIFLUOROETHYL TRIFLUOROACETATE $CF_3.CO_2CH_2CF_3$

**Constants:** SWARTS (1923–31–34)

*Boiling point:* 55° *Freezing point:* −65°

| *Density* | | *Viscosity* | | *Refractive index* | | | |
|---|---|---|---|---|---|---|---|
| t° | d | t° | $\eta \cdot 10^5$ | t° | Hα | D | Hg (546) |
| 0 | 1.5179 | 20 | 672 | 18 | 1.2799 | 1.2812 | 1.2823 |
| 18 | 1.4725 | 30 | 580.6 | | | | |
| 40 | 1.4174 | 40 | 506.7 | | | | |

ETHYL MONO, DI and TRICHLOROACETATES: $CH_2Cl$; $CHCl_2$; $CCl_3CO_2C_2H_5$: *Boiling point:* LECAT (passim); *density* and *surface tension:* DESREUX (1935): *density:* KREMANN, MEINGAST and GUGL (1914) and *heat of combustion:* SCHJÄNBERG (1934–35).
*d*-β-OCTYL CHLOROACETATE, BROMOACETATE and IODOACETATE: $CH_2Cl.CO_2C_8H_{17}$, $CH_2Br.CO_2C_8H_{17}$ and $CH_2I.CO_2C_8H_{17}$: RULE and MITCHELL (1926).

ETHYL TRICHLOROBUTYRATE, BROMOACETATE, BROMOPROPIONATE, BROMOBUTYRATE and BROMO-*iso*-BUTYRATE: $CCl_3.CH_2.CH_2.CO_2C_2H_5$, $CH_2Br.CO_2C_2H_5$, $CH_2Br.CH_2.CO_2C_2H_5$, $CH_2Br.CH_2.CH_2.CO_2C_2H_5$ and $(CH_3)_2CBr.CO_2C_2H_5$:

*Boiling point, density refractive index, magnetic rotatory power:* PERKIN (1894).

ETHYL BROMODI-*n*-PROPYLACETATE: $CBr(n\text{-}C_3H_7)_2.CO_2C_2H_5$: *Boiling point, density, refractive index:* EYKMAN (1919).

METHYL and ETHYL BROMOPROPIONATES: $CH_2Br.CH_2.CO_2CH_3$ and $CH_2Br.CH_2.CO_2C_2H_5$: *Boiling point, density, rotatory power:* WALKER (1909).

ETHYL DICHLOROSUCCINATE: $C_2H_5CO_2.(CHCl)_2.CO_2C_2H_5$: *Boiling point, density, rotatory power:* WOOD and NICHOLAS (1928).

## FLUOROPHENOLS $C_6H_4F.OH$

| | *Ortho* | *Meta* | *Para* |
|---|---|---|---|
| **Constants** | | | |
| *Boiling point:* | 151° | 177°8 | 185°6 |
| | SWARTS (1912) | SWARTS (1919) | SWARTS (1919) |
| *Freezing point:* | | | |
| | 16°1 SWARTS (1913–19) | 13°5 SWARTS (1919) | 48°2 (st.) SWARTS (1919) |
| | 16°1 SCHIEMANN (1931) | 13°7 SCHIEMANN (1931) | 28°5 (unst.) „ |
| | — | 13°8 SWARTS (1913) | — |
| *Density:* | — | 15°2 1.22176 SWARTS (1923) | — |
| | 15°8 1.2172 SCHIEMANN (1931) | 20° 1.2133 SCHIEMANN (1931) | — |
| *Refractive index:* | | | — |
| | — | 15°2 | — |
| | Hα — | 1.51218 | — |
| | D — | 1.51650 | — |
| | Hβ — | 1.52903 | — |
| | Hγ — | 1.53991 | — |
| | | SWARTS (1923) | — |

## FLUOROPHENETOLES $C_6H_4F{\cdot}OC_2H_5$

| | *Ortho* | *Meta* | *Para* | |
|---|---|---|---|---|
| **Constants** | | | | |
| *Boiling point* | — | 171°6 | 172°5 | SWARTS (1913–19) |
| *Melting point* | −16°7 | — | −8°5 | „ |
| *Density* | 13°4 1.08715 | 16°7 1.0720 | 18°2 1.07148 | „ (1919–23) |

## FLUOROPHENETOLES $C_6H_4F{\cdot}OC_2H_5$ (continued)

| | *Ortho* | | *Meta* | | *Para* | | |
|---|---|---|---|---|---|---|---|
| *Viscosity:* $\eta \cdot 10^5$ | 20°05 | 1520 | 20° | 1314 | 20°15 | 1340 | Swarts (1931) |
| | 30° | 1250 | 30°1 | 1090 | 30° | 1113 | ,, |
| | 40° | 1057 | 40°03 | 930 | 40° | 950 | ,, |
| | 49°95 | 917 | 44°95 | 860 | 50° | 820 | ,, |
| | | | 50° | 804 | 60° | 715 | ,, |
| | | | 60° | 703 | | | ,, |
| *Refractive index* | | | | | | | |
| Hα | 13°4 | 1.48922 | 16°7 | 1.4805 | 18°2 | 1.4787 | Swarts (1923) |
| D | | 1.49332 | | 1.48491 | | 1.48257 | ,, |
| Hβ | | 1.50410 | | 1.49602 | | 1.49329 | ,, |
| Hγ | | 1.51360 | | 1.50500 | | 1.50242 | ,, |

CHLOROACETOPHENONE: $C_6H_5.CO.CH_2Cl$: *Saturated vapour pressure:* Balson(1947)
MONOCHLOROQUINONE: $C_6H_3ClO_2$; MONOCHLOROQUINOL: $C_6H_3Cl(OH)_2$;
2,6-DICHLOROQUINONE: $C_6H_2Cl_2O_2$; 2,6-DICHLOROQUINOL: $C_6H_2Cl_2(OH)_2$;
TRICHLOROQUINONE: $C_6H\,Cl_3O_2$; TRICHLOROQUINOL: $C_6H\,Cl_3(OH)_2$;
TETRACHLOROQUINONE: $C_6Cl_4O_2$; TETRACHLOROQUINOL: $C_6Cl_4(OH)_2$;
*Sublimation pressure:* Coolidge and Coolidge (1927).

## CHLOROBENZOIC ACIDS $C_6H_4Cl.CO_2H$

### Constants

| | *Ortho* | *Meta* | *Para* | |
|---|---|---|---|---|
| *Melting point* | 140°2 | 154°25 | 239°7 | Andrews, Lynn and Johnston (1926) |
| | 139°5 | 156° | 240°0 | Flaschner and Rankin (1910) |
| | — | 155° | — | Hope and Riley (1922) |
| *Specific heat* | L. 140°2 0.442 | L. 154°25 0.414 | L. 239°7 0.547 | Andrews, Lynn and Johnston (1926) |
| | C. ,, 0.346 | C. ,, 0.344 | C. ,, 0.375 | |
| | C. 25° 0.249 | C. 25° 0.250 | C. 25° 0.256 | ,, |
| *Heat of melting* cal 15°/g | 39.27 | 36.39 | 49.23 | ,, |

*d*-OCTYL CHLORO, BROMO, IODOBENZOATES: $C_6H_4R.CO_2C_8H_{17}$ (R=Cl, Br, I)

*Boiling point, density* and *rotatory power:* RULE, HAY, NUMBERS and PATTERSON (1928).

HALOGENATED METHYL BENZOYLTARTRATES: $(RC_6H_4.CO_2CH.CO_2CH_3)_2$ (R=Cl, Br, I)

*Melting point, density* and *rotatory power:* FRANKLAND, CARTER and ADAMS (1912).

ETHYL, *n*-PROPYL and *n*-BUTYL PHENYLCHLOROACETATES: $C_6H_5.HCl.CO_2R$ (R= $C_2H_5$, $n$-$C_3H_7$ and $n$-$C_4H_9$)

*Boiling point, density* and *rotatory power:* WALKER (1909).

## BENZOYL CHLORIDE $C_6H_5COCl$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 85.4 | 17.6 | 94.1 | 26.3 | 101.2 | 35.7 | KAHLBAUM (1898) |
| 86.4 | 18.5 | 96.2 | 28.3 | 102.1 | 37.2 | ,, |
| 87.8 | 19.5 | 96.4 | 29.0 | 103.1 | 38.6 | ,, |
| 88.6 | 20.4 | 97.2 | 30.1 | 104.0 | 40.2 | ,, |
| 90.5 | 21.2 | 98.5 | 31.9 | 104.6 | 41.2 | ,, |
| 90.7 | 22.4 | 99.5 | 33.3 | 105.5 | 42.8 | ,, |
| 92.3 | 24.3 | 100.6 | 34.9 | | | ,, |
| 79 | 13 | 82.5 | 15.5 | 92.5 | 25 | HOPE and RILEY (1922) |

*Boiling point*

| | | | |
|---|---|---|---|
| 196°7 | HOPE and RILEY (1922) | 197° | MATSUNO and HAN (1933) |
| | | 197°9 | KAMERLINGH and SMYTH (1933) |

*Melting point*

| | |
|---|---|
| −0°6 | KAMERLINGH and SMYTH (1933) |

*Density*

| | | | | | |
|---|---|---|---|---|---|
| 15° | 1.2188 | LUMSDEN (1905) | 15° | 1.2187 | MATSUNO and HAN (1933) |

*Refractive index*

| | | | | | |
|---|---|---|---|---|---|
| $n_D^{15°}$ | 1.55799 | LUMSDEN (1905) | $n_D^{20°}$ | 1.55354 | KAMERLINGH and SMYTH (1933) |
| $n_D^{15°}$ | 1.5579 | MATSUNO and HAN (1933) | | | |

*Ortho, Meta* and *Para*-CHLOROBENZOYL CHLORIDES: $C_6H_4Cl.COCl$.

*Saturated vapour pressure* and *boiling point.* HOPE and RILEY (1922).

# 9. NITROGEN DERIVATIVES of the ALIPHATIC SERIES

## A. AMINES

These compounds are very sensitive to small amounts of water and carbon dioxide.

### METHYLAMINE $CH_3NH_2$

**Constants. — Polyphasic equilibria**

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 156.9 | 73.6 | Berthoud (1917) |

*Saturated vapour pressure*

The values of Berthoud (1917), Felsing and Thomas (1929) and Hsia (1931) do not agree.

| t° | p mm | t° | p mm | |
|---|---|---|---|---|
| −83.162 | 4.06 | −28.758 | 247.20 | Aston, Siller and Messerly (1937) |
| −74.256 | 9.59 | −23.625 | 326.65 | " |
| −63.228 | 19.19 | −17.562 | 446.09 | " |
| −58.895 | 34.75 | −17.232 | 453.40 | " |
| −51.184 | 60.67 | −12.558 | 569.33 | " |
| −44.676 | 94.29 | −10.695 | 621.74 | " |
| −37.111 | 151.85 | − 8.369 | 693.03 | " |
| −36.700 | 155.86 | − 6.286 | 761.55 | " |
| −33.401 | 189.68 | − 5.948 | 773.25 | " |
| −29.636 | 235.42 | | | " |

*Isotherms:* Kenner and Felsing (1939)

*Boiling point*

| | | | |
|---|---|---|---|
| −7°5–7°6/719 mm | Berthoud (1917) | −6°45 | Hsia (1931) |
| −6°79 | Felsing and Thomas (1929) | −6°32 | Aston, Siller and Messerly (1937) |
| −6°7 | Gibbs (1905) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −92°5 | Timmermans | −93°469 | Aston, Siller ans Messerly (1937) |
| −93°4 | Mac Neight and Smith (1936) | | |

## Constants of state

*Density:* Felsing and Thomas (1929)

| t° | d | t° | d | t° | d | t° | d |
|---|---|---|---|---|---|---|---|
| −82.58 | 0.77787 | −44.31 | 0.73719 | −11.00 | 0.6992 | 10.99 | 0.67335 |
| −73.19 | 0.76903 | −36.37 | 0.72884 | −10.80 | 0.699 | 17.21 | 0.66575 |
| −64.25 | 0.75850 | −20.94 | 0.71124 | − 6.30 | 0.69423 | 19.79 | 0.66277 |
| −55.52 | 0.74931 | −13.60 | 0.70273 | + 1.86 | 0.68447 | | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 20.60 | Swift Jr. and Calkins |
| 25 | 19.19 | ,, (1943) |
| 35 | 17.65 | ,, |

## Heat constants

*Specific heat:* Aston, Siller and Messerly (1937) (M.W. 31.057)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −260.45 | 0.01002 | −210.32 | 0.2030 | −161.60 | 0.3503 | − 96.25 | 0.5319 |
| −258.40 | 0.01401 | −206.23 | 0.2213 | −156.15 | 0.3600 | L. − 84.81 | 0.7680 |
| −255.91 | 0.02193 | −202.05 | 0.2342 | −150.68 | 0.3684 | − 78.89 | 0.7657 |
| −251.97 | 0.03846 | −197.52 | 0.2478 | −145.65 | 0.3777 | − 72.26 | 0.7683 |
| −250.11 | 0.04564 | −192.77 | 0.2616 | −140.26 | 0.3867 | − 66.52 | 0.7702 |
| −248.15 | 0.05427 | −188.46 | 0.2770 | −135.76 | 0.3139 | − 60.69 | 0.7751 |
| −246.41 | 0.05943 | −184.04 | 0.2901 | −128.95 | 0.3999 | − 54.44 | 0.7780 |
| −244.46 | 0.06909 | −183.39 | 0.3021 | −123.60 | 0.4115 | − 48.88 | 0.7754 |
| −240.69 | 0.08716 | −181.94 | 0.3069 | −117.37 | 0.4202 | − 42.32 | 0.7776 |
| −233.33 | 0.1014 | −179.27 | 0.3120 | −117.34 | 0.4251 | − 36.07 | 0.7799 |
| −228.54 | 0.1233 | −176.91 | 0.3202 | −111.57 | 0.4312 | − 30.55 | 0.7851 |
| −224.11 | 0.1468 | −173.61 | 0.3275 | −105.96 | 0.4408 | − 24.53 | 0.7854 |
| −219.44 | 0.1673 | −170.46 | 0.3339 | −100.94 | 0.4553 | − 18.43 | 0.7851 |
| −214.61 | 0.1854 | −167.58 | 0.3397 | − 98.40 | 0.4704 | − 13.88 | 0.7835 |

| | | |
|---|---|---|
| *Heat of vaporization* | (B.P.) 198.6 cal 15° g | Aston, Siller and Messerly (1937) |
| *Heat of melting* | 47.197 ,, | |

# ETHYLAMINE $C_2H_5NH_2$

## Constants

*Critical constants*

| t° cr. | p cr. atm. | |
|---|---|---|
| 183.2 | 55.54 | Berthoud (1917) |

*Densities of the liquid and the saturated vapour*

| t° | V. | t° | L. | V. | |
|---|---|---|---|---|---|
| 29.2 | 0.00309 | 134.9 | — | 0.0459 | Pohland and Mehl (1933) |
| 35.3 | 0.00377 | 138.3 | 0.5007 | — | „ |
| 80.4 | 0.0118 | 147.2 | 0.4816 | — | „ |
| 92.0 | 0.0172 | 170.9 | — | 0.1072 | „ |
| 99.6 | 0.0211 | 178.1 | — | 0.1393 | „ |
| 125.4 | 0.0373 | 183.4 | — | 0.2434 | „ |
| 130.5 | 0.0420 | | | | „ |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 15.45 | 723.52 | 110.2 | 11658.4 | 171.2 | 35066.4 | Berthoud (1917) |
| 46.0 | 2090.0 | 130.6 | 17434.4 | 178.1 | 39109.6 | „ |
| 73.6 | 4810.8 | 144.8 | 22480.8 | 183.2 | 42210.4 | „ |
| 93.8 | 8071.2 | 162.2 | 30286 | | | „ |
| −61.29 | 7.4 | −17.81 | 147.8 | 5.76 | 481.3 | Pohland and Mehl (1933) |
| −53.84 | 13.8 | −13.95 | 183.0 | 10.64 | 594.8 | „ |
| −45.23 | 26.3 | − 9.25 | 234.9 | 16.24 | 750.5 | „ |
| −34.27 | 55.6 | − 5.65 | 281.8 | 21.62 | 928.8 | „ |
| −29.79 | 74.3 | 0.0 | 369.9 | 23.81 | 1011.8 | „ |
| −22.89 | 111.2 | 0.27 | 374.4 | | | „ |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 16°45 | Berthoud (1917) | −80°5 | Timmermans |
| 16°5 | Pohland and Mehl (1933) | −81° | Pohland and Mehl (1933) |
| 16°55 | $\frac{dt}{dp}$ *(10 mm)*: 0°28 Timmermans (1910—12) and Lecat (passim) | | |

*Density*

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| −72.65 | 0.7854 | −38.12 | 0.7489 | 0.0 | 0.7059 | Pohland and Mehl (1933) |
| −59.04 | 0.7705 | −23.81 | 0.7330 | 10.10 | 0.6949 | „ |
| −49.55 | 0.7610 | −10.76 | 0.7186 | 19.40 | 0.6837 | „ |
| 0 | 0.70566 | 15 | 0.68858 | 25 | 0.67687 | Swift Jr. (1942) |
| 35 | 0.66482 | — | — | — | — | „ |
| 0 | 0.70570 | — | — | — | — | Timmermans (1910–12) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 20.56 | Swift Jr. and Calkins (1943) |
| 25 | 19.21 | „ |
| 35 | 17.82 | „ |

## DIMETHYLAMINE $(CH_3)_2NH$

**Constants:** Aston, Eidinoff and Forster (1939)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −71.773 | 4.86 | −23.530 | 172.13 | +2.774 | 636.50 |
| −59.358 | 14.69 | −16.711 | 249.54 | 4.520 | 686.45 |
| −51.082 | 28.35 | −10.183 | 348.06 | 6.800 | 757.37 |
| −41.023 | 58.32 | − 2.978 | 491.22 | 6.858 | 758.62 |
| −31.082 | 110.58 | | | | |

*Boiling point*

| | |
|---|---|
| 6°88 | Aston, Eidinoff, etc. (1939) |
| 7°3 | Lecat |

*Melting point*

| | |
|---|---|
| −92°19 | Aston, Eidinoff, etc. (1939) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.67862 | Swift Jr. (1942) | 25 | 0.64964 | Swift Jr. (1942) |
| 15 | 1.66158 | „ | 35 | 0.63732 | „ |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 207 | Swift Jr. and Wolfe | 15 | 17.61 | Swift Jr. and Calkins |
| 25 | 186 | „ (1944) | 25 | 16.33 | „ (1943) |
| 35 | 167 | „ | 35 | 15.08 | „ |

*Specific heat:* Aston, Eidinoff and Forster (1939)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.84 | 0.0154 | −193.09 | 0.23706 | −125.52 | 0.36431 | −57.81 | 0.69251 |
| −255.03 | 0.02730 | −187.52 | 0.24906 | −121.23 | 0.7096 | −52.98 | 0.69832 |
| −252.15 | 0.03924 | −183.16 | 0.25061 | −120.26 | 0.37250 | −48.33 | 0.70196 |
| −249.33 | 0.04988 | −182.33 | 0.26097 | −116.22 | 0.37915 | −43.52 | 0.70626 |
| −246.44 | 0.05971 | −178.07 | 0.26239 | −115.35 | 0.37981 | −38.20 | 0.70926 |
| −243.33 | 0.07415 | −173.26 | 0.27273 | −111.18 | 0.38483 | −32.94 | 0.71219 |
| −239.66 | 0.08881 | −168.66 | 0.28295 | −110.60 | 0.38543 | −27.46 | 0.71425 |
| −235.64 | 0.1052 | −164.28 | 0.30079 | −106.47 | 0.39268 | −22.36 | 0.71500 |
| −231.14 | 0.1241 | −160.06 | 0.30870 | −101.44 | 0.39958 | −17.33 | 0.71711 |
| −226.99 | 0.1380 | −154.37 | 0.31866 | − 97.05 | 0.40938 | −12.35 | 0.71804 |
| −223.44 | 0.1495 | −149.46 | 0.32725 | L. − 88.34 | 0.64314 | − 7.33 | 0.72017 |
| −219.32 | 0.1642 | −144.61 | 0.33486 | − 82.97 | 0.65336 | − 2.42 | 0.72146 |
| −214.33 | 0.1795 | −140.12 | 0.34253 | − 77.72 | 0.66315 | + 2.39 | 0.72394 |
| −208.84 | 0.1952 | −135.66 | 0.34910 | − 72.59 | 0.67177 | 7.29 | 0.72514 |
| −203.36 | 0.2112 | −130.81 | 0.35655 | − 67.56 | 0.67983 | | |
| −198.37 | 0.22442 | −126.40 | 0.36218 | − 62.64 | 0.68608 | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 140.47 cal 15°/g | Aston, Eidinoff and Forster (1939) |
| *Heat of melting* | 31.514 „ | „ |

## DIETHYLAMINE $(C_2H_5)_2NH$

### Constants

*Saturated vapour pressure:* Pohland and Mehl (1933)

| t° | p mm | t | p mm | t° | p mm |
|---|---|---|---|---|---|
| −41.1 | 5.9 | −12.4 | 35.1 | 12.8 | 127.3 |
| −28.9 | 12.8 | 0.0 | 70.0 | 20.7 | 194.4 |

*Boiling point*

| | |
|---|---|
| 55·5 | Marshall (1906) |
| 55°9 | Lecat |

*Melting point*

| | |
|---|---|
| −50° | Somerville (1931) |
| −50° | Pohland and Mehl (1933) |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.72513 | Swift Jr. (1942) |
| 15 | 0.709435 | „ |
| 25 | 0.69894 | „ |
| 35 | 0.68815 | „ |

*Surface tension*

| t° | γ | |
|---|---|---|
| 15 | 20.63 | Swift Jr. and Calkins (1943) |
| 25 | 19.39 | „ |
| 35 | 18.20 | „ |

## TRIMETHYLAMINE $(CH_3)_3N$

**Constants:** Aston, Sagenkahn, Szasz, Moessen and Zuhr (1944)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| −80.325 | 6.04 | −41.784 | 94.12 | −20.174 | 288.03 | −3.123 | 601.61 |
| −74.091 | 10.25 | −35.627 | 132.64 | −15.984 | 348.82 | +0.770 | 701.27 |
| −62.349 | 25.16 | −28.517 | 192.20 | −11.432 | 426.05 | 2.918 | 761.51 |
| −51.948 | 50.83 | −24.165 | 238.31 | − 8.995 | 472.83 | +3.444 | 777.15 |
| −46.852 | 69.79 | −23.077 | 251.23 | −7.409 | 505.14 | | |

| | | | | |
|---|---|---|---|---|
| 0 | 683 | 30 | 1946 | Swift Jr. and Hochanadel (1945) |
| 15 | 1189 | 35 | 2266 | „ |
| 20 | 1415 | 40 | 2621 | „ |
| 25 | 1663 | | | „ |

*Boiling point:* +2°87 *Melting point:* −117°08

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 194 | Swift Jr. and Wolfe (1944) |
| 25 | 177 | „ |
| 35 | 161 | „ |

*Specific heat:* (M.W. 59.112)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −261.28 | 0.00890 | −198.50 | 0.19397 | −144.38 | 0.2987 | −61.35 | 0.4835 |
| −259.17 | 0.0127 | −193.68 | 0.20317 | −143.71 | 0.3003 | −56.47 | 0.4865 |
| −257.12 | 0.02100 | −191.61 | 0.2071 | −138.86 | 0.3094 | −51.44 | 0.4884 |
| −254.24 | 0.03209 | −185.41 | 0.2189 | −133.80 | 0.3216 | −46.40 | 0.4913 |
| −251.59 | 0.04348 | −183.29 | 0.2225 | −128.74 | 0.3524 | −41.40 | 0.4943 |
| −247.95 | 0.05889 | −180.02 | 0.2292 | | | −36.21 | 0.5001 |
| −243.24 | 0.07927 | −178.72 | 0.2321 | L. −124.74 | 0.4481 | −32.54 | 0.5026 |
| −239.24 | 0.09379 | −174.82 | 0.2409 | −112.28 | 0.4666 | −31.03 | 0.5038 |
| −234.72 | 0.1086 | −173.71 | 0.2426 | −107.08 | 0.4676 | −27.28 | 0.5067 |
| −230.92 | 0.1202 | −168.88 | 0.2509 | −101.96 | 0.4681 | −14.50 | 0.5175 |
| −225.98 | 0.1332 | −166.17 | 0.2563 | − 96.87 | 0.4703 | − 8.78 | 0.5232 |
| −220.80 | 0.1447 | −163.66 | 0.2614 | − 91.45 | 0.4728 | − 2.71 | 0.5285 |
| −215.73 | 0.1560 | −158.43 | 0.2713 | − 70.96 | 0.4784 | + 2.74 | 0.5329 |
| −214.49 | 0.1585 | −155.53 | 0.2774 | − 66.23 | 0,4808 | | |
| −210.25 | 0.1673 | −153.29 | 0.2818 | | | | |
| −203.53 | 0.18272 | −148.53 | 0.2913 | | | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 92.799 cal 15°/g | |
| | (23°16) 98.558 „ | |
| *Heat of melting* | 26.473 „ | |

## TRIETHYLAMINE $(C_2H_5)_3N$

**Constants:** B.E. (1932)

*Boiling point:* 89°35 $\frac{dt}{dp}$ *(10 mm):* 0°42 B.E. (1932) and Lecat

*Freezing point:* −114°7

*Critical solution point in water:* 18°20

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.74620 | B.E. (1932) | 12.52 | 0.7348 | Friend and Hargreaves |
| 15 | 0.73255 | „ | 49.6 | 0.6999 | „ (1944) |
| 30 | 0.71899 | „ | 60.7 | 0.6900 | „ |
| | | | 70.5 | 0.6794 | „ |
| | | | 80.0 | 0.6704 | „ |
| | | | 85.9 | 0.6650 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 394 | B.E. (1932) |
| 30 | 323 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 21.25 | B.E. (1932) |
| 20 | 20.66 | „ |
| 30 | 19.62 | „ |
| 0 | 22.92 | Merzlin (1935) |
| 15 | 21.08 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.40080 | 1.40133 | 1.40368 | 1.40835 | 1.40969 | 1.41317 |
| $\frac{dn}{dt}$ | 0.00054 | 54 | 54 | 54 | 55 | 55 |

*Dielectric constant*

| t° | $\varepsilon$ | | t° | $\varepsilon$ | |
|---|---|---|---|---|---|
| 12.5 | 3.704 | Friend and Hargreaves | 70.5 | 2.316 | Friend and Hargreaves |
| 49.6 | 2.760 | „ (1944) | 80.0 | 2.137 | „ (1944) |
| 60.7 | 2.520 | „ | 85.9 | 2.028 | „ |

*n*-PROPYLAMINE: *n*-$C_3H_7NH_2$: *Critical constants, saturated vapour pressure* and *boiling point:* Berthoud (1917); *boiling point:* Lecat (passim); *density* and *refractive index:* Eykman (1893–1919).

*n*-BUTYLAMINE: *n*-$C_4H_9NH_2$ and *n*-HEPTYLAMINE: *n*-$C_7H_{15}NH_2$: *Boiling point, density* and *viscosity:* Friend and Hargreaves (1944); *density, refractive index:* Eykman (1893–1919).

*n*-ALKYLAMINE: R $NH_2$(R = *n*-$C_6H_{13}$ → *n*-$C_{18}H_{37}$): *Boiling point* and *saturated vapour pressure:* Ralston, Selby, Pool and Potts (1940).

DI-*n*-PROPYLAMINE: (*n*-$C_3H_7)_2NH$ and DI-*n*-BUTYLAMINE: (*n*-$C_4H_9)_2NH$: *Density* and *dielectric constant:* Friend and Hargreaves (1944).

TRI-*n*-BUTYLAMINE: (*n*-$C_4H_9)_3N$ TRI-*n*-AMYLAMINE: (*n*-$C_5H_{11})_3N$ and TRI-*iso*-AMYLAMINE: $[(CH_3)_2CH.CH_2.CH_2]_3N$: *Specific volume* and *fluidity.* Bingham and Spooner (1932).

ETHYLENEDIAMINE: $NH_2CH_2.CH_2NH_2$: *Boiling point:* (Lecat, passim); *density* and *refractive index:* Brühl (1895); *density* and *viscosity:* Friend and Hargreaves (1944).

# B. HYDROGEN CYANIDE; NITRILES

## HYDROGEN CYANIDE HCN

Purified by fractional distillation over $P_2O_5$.

### Constants

*Saturated vapour pressure*

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| S. | −85.01 | 0.132 | −51.26 | 7.48 | −19.08 | 96.26 | Sinozaki, Hara and Mitsukuri (1926) |
| | −78.58 | 0.376 | −46.10 | 11.78 | −18.64 | 97.97 | „ |
| | −73.34 | 0.745 | −44.08 | 13.92 | −15.27 | 131.29 | „ |
| | −66.66 | 1.562 | −39.97 | 19.72 | −15.23 | 131.93 | „ |
| | −65.99 | 1.673 | −34.23 | 31.24 | −13.92 | 134.29 | „ |
| | −60.69 | 2.97 | −29.14 | 46.26 | −13.54 | 137.45 | „ |
| | −55.58 | 4.97 | −24.32 | 66.03 | | | „ |
| L. | −13.18 | 140.78 | +0.08 | 265.2 | 24.65 | 730.6 | „ |
| | −13.03 | 142.32 | 4.09 | 316.8 | 27.68 | 816.2 | „ |
| | −11.98 | 149.80 | 6.97 | 358.6 | 30.25 | 911.1 | „ |
| | −10.98 | 157.58 | 10.99 | 407.8 | 33.98 | 1028.4 | „ |
| | −10.25 | 163.16 | 13.17 | 465.4 | 36.68 | 1128.2 | „ |
| | − 7.47 | 186.54 | 15.88 | 519.4 | 40.15 | 1272.2 | „ |
| | − 4.14 | 219.81 | 18.87 | 584.7 | 42.92 | 1393.2 | „ |
| | − 0.70 | 256.31 | 21.80 | 654.4 | 46.29 | 1564.1 | „ |
| L. | −8.017 | 181.70 | +3.121 | 304.11 | 16.829 | 540.43 | Ruehrwein and Giauque (1939) |
| | −5.083 | 209.15 | 6.990 | 360.03 | 22.085 | 658.73 | „ |
| | −1.096 | 251.78 | 11.920 | 442.84 | 25.701 | 760.16 | „ |
| | 0 | 265.0 | — | — | — | — | Smyth and Mac Alpine (1934) |

*Boiling point*

| | | | |
|---|---|---|---|
| 25°70 | Ruehrwein and Giauque (1939) | 25°7 | Coates and Taylor (1936) |
| 25°70 | Sinozaki, Hara and Mitsukuri (1926) | 25°75 | Lowry and Henderson (1932) |
| 25°7 | Lecat | 25°93 | Smyth and Mac Alpine (1934) |

*Freezing point*

| | | | |
|---|---|---|---|
| −13°27 | Coates and Coates (1944) | −13°35 | Coates and Taylor (1936) |
| −13°3 | Coates and Hartshore (1931) | −13°35 | Lowry and Henderson (1932) |
| −13°34 | Lespieau (1905) | −13°40 | Tammann (1899) |

*Triple point*

| | | |
|---|---|---|
| −13°244 | 140.40 mm | Ruehrwein and Giauque (1939) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 10.0 | 0.7018 | Meyer and Hopff (1931) | 18 | 0.69004 | Coates and Hartshore (1931) |
| 18 | 0.68998 | Coates and Taylor (1936) | 20 | 0.6876 | Lowry and Henderson (1932) |

*Viscosity* $\eta \cdot 10^5$: 18° 206 Coates and Taylor (1932)

*Refractive index*

| t° | Li (6707.36) | D | Hg (4358.24) | |
|---|---|---|---|---|
| 20 | 1.25994 | 1.26136 | 1.26700 | Lowry and Henderson (1932) |

*Specific heat:* Ruehrwein and Giauque (1939)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −258.33 | 0.0138 | −198.42 | 0.2379 | −129.48 | 0.3658 | −82.80 | 0.4264 |
| −256.25 | 0.0194 | −193.31 | 0.2515 | −124.35 | 0.3716 | −76.78 | 0.4353 |
| −254.16 | 0.0276 | −188.17 | 0.2650 | −123.78 | 0.3746 | −71.00 | 0.4449 |
| −251.46 | 0.03750 | −183.15 | 0.2760 | −119.06 | 0.3801 | −65.34 | 0.4523 |
| −247.28 | 0.05267 | −178.13 | 0.2857 | −115.21 | 0.3857 | −59.67 | 0.4623 |
| −243.31 | 0.06678 | −171.04 | 0.3008 | −113.81 | 0.3864 | −48.36 | 0.4842 |
| −240.25 | 0.08262 | −166.16 | 0.3090 | −108.67 | 0.3931 | −42.16 | 0.4967 |
| −237.00 | 0.09650 | −161.50 | 0.3183 | −106.80 | 0.3961 | −36.44 | 0.5097 |
| −233.67 | 0.1112 | −156.25 | 0.3270 | −106.70 | 0.3968 | −30.59 | 0.5215 |
| −229.67 | 0.1287 | −150.62 | 0.3344 | −100.37 | 0.4046 | −24.67 | 0.5356 |
| −225.43 | 0.1458 | −148.43 | 0.3376 | − 98.68 | 0.4053 | −18.96 | 0.5475 |
| −221.38 | 0.1633 | −145.17 | 0.3422 | − 97.29 | 0.4057 | L. − 1.34 | 0.6226 |
| −217.95 | 0.1805 | −139.91 | 0.3499 | − 96.06 | 0.4075 | + 4.05 | 0.6233 |
| −212.57 | 0.1953 | −139.76 | 0.3505 | − 95.52 | 0.4086 | 20.92 | 0.6270 |
| −208.10 | 0.2083 | −134.68 | 0.3565 | − 91.59 | 0.4142 | 24.02 | 0.6278 |
| −203.29 | 0.2236 | −132.00 | 0.3620 | − 89.49 | 0.4164 | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 223.1 cal 15° g | Ruehrwein and Giauque (1939) |
| *Heat of melting* | 74.38 „ | „ |

# NITRILES

The nitriles are prepared by dehydration of the corresponding amides by $P_2O_5$; this method yields a very pure product.

Another method consists in treating the iodide or bromide of the next lower homologue with alkaline cyanide; in this case, the product is contaminated with isonitrile, but this impurity can be eliminated by shaking with *0.1 N* hydrochloric acid.

The series of homologous normal nitriles from $C_2$ to $C_{14}$ was studied with great care by Merckx, Verhulst and Bruylants in (1933) and their results agree well with those obtained by the B.E. (1930). Yet the densities, although in complete agreement at 15°, differ slightly at 0° and 30°. As for the refractive indices, the results of various collaborators at Brussels are in perfect concordance; we found, however, a systematic difference with the values given at Louvain. Nevertheless the values of the saturated vapour pressure agree perfectly. It follows that the discrepancies arise more probably from a systematic error either during the experiments or in calibrating the apparatus, rather than from the degree of purity of the materials; on the other side, the vapour pressure curve of Heim (1933) does not always agree with the boiling point measurements of his colleagues of Louvain.

## ACETONITRILE $CH_3CN$

**Constants:** B.E. (1930). — **Polyphasic equilibria**

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 274.74 | 0.2371 | Ter Gazarian (1906) |

*Densities of the liquid and the saturated vapour:* Ter Gazarian (1906)

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 212.34 | 0.5340 | 0.0248 | 245.77 | 0.4527 | 0.0589 |
| 213.46 | 0.5301 | 0.0271 | 249.02 | 0.4403 | 0.0660 |
| 218.83 | 0.5147 | 0.0331 | 252.01 | 0.4291 | 0.0728 |
| 223.15 | 0.5066 | 0.0358 | 262.00 | 0.3932 | 0.0963 |
| 227.72 | 0.4983 | 0.0388 | 264.17 | 0.3796 | 0.1073 |
| 232.61 | 0.4863 | 0.0438 | 266.61 | 0.3654 | 0.1162 |
| 236.52 | 0.4756 | 0.0480 | 269.00 | 0.3502 | 0.1288 |
| 240.50 | 0.4637 | 0.0538 | 269.98 | 0.3425 | 0.1377 |
| 243.04 | 0.4594 | 0.0554 | 270.92 | 0.3355 | 0.1455 |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 15.5 | 54.9 | 20.5 | 70.6 | — | — | Joukovsky (1934) |
| 18.0 | 62.2 | 22.8 | 78.6 | — | — | „ |
| 20 | 70.9 | 25 | 89.0 | 30 | 111.8 | Ewert (1937) |
| 19.99 | 70.7 | 49.48 | 249.1 | 79.46 | 707.3 | Heim (1933) |
| 25.50 | 91.4 | 54.44 | 300.3 | 89.66 | 970.5 | „ |
| 30.05 | 111.7 | 59.65 | 363.2 | 94.52 | 1117.9 | „ |
| 34.88 | 137.8 | 64.95 | 437.4 | 99.89 | 1303.9 | „ |
| 39.45 | 166.7 | 70.05 | 521.6 | 104.30 | 1473.2 | „ |
| 44.50 | 205.2 | 74.77 | 613.1 | | | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 81°52 | Merckx, Verhulst and Bruylants (1933) | 81°60 | Koch (1927) |
| | | 81°6 | Cowley and Partington (1935) |
| 81°54 | Louguinine (1900–1899) | 81°6 | Lecat |
| 81°60 | B.E. (1930) | 81°7 | Radice (1899) |
| 81°60 | Grimm and Patrick (1923) | 81°73 | Heim (1933) |

$\frac{dt}{dp}$*(10 mm):* *Freezing point*

| | | | |
|---|---|---|---|
| 0°35 | Lecat | −44°9 | B.E. (1930) |
| 0°40 | B.E. (1930) | −45° | Joukovsky (1934) |
| 0°43 | Heim (1933) | −45°2 | Ewert (1937) |

**Constants of state**

*Density*

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| −45.0 | 0.85124 | −30.6 | 0.83592 | − 6.2 | 0.81013 | Timmermans (1912) |
| −37.2 | 0.84288 | −22.95 | 0.82774 | 0 | 0.80350 | „ |
| −35.3 | 0.84074 | −13.1 | 0.81724 | +18.2 | 0.78417 | „ |
| 0 | 0.8034 | Ter Gazarian | | 0 | 0.80345 | B.E. (1930) |
| 13.4 | 0.7893 | „ (1906) | | 15 | 0.78746 | „ |
| 23.4 | 0.7784 | „ | | 30 | 0.77141 | „ |

*Density* (continued)

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.80345 | Ewert (1937) | 0 | 0.80377 | Merckx, Verhulst and Bruylants (1933) |
| 15 | 0.78746 | „ | 15 | 0.78743 | |
| 30 | 0.77148 | „ | 30 | 0.77125 | „ |
| 0 | 0.80345 | Joukovsky (1934) | 20 | 0.7822 | Groves and Sugden (1937) |
| 0 | 0.8036 | Radice (1899) | 20 | 0.7823 | Cowley and Partington (1935) |
| 0 | 0.8036 | Walden (1908) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 375 | |
| 30 | 325 | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 29.76 | |
| 20 | 29.10 | |
| 30 | 27.80 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.34436 | 1.34464 | — | 1.34638 | 1.34964 | 1.35055 | 1.35306 | 1.35396 | B.E. (1930) |
| $\frac{dn}{dt}$ | 0.00045 | 46 | — | 45 | 45 | 47 | 45 | 47 | „ |
| 15 | 1.34415 | 1.34451 | 1.34604 | 1.34615 | 1.34943 | 1.35030 | 1.35258 | 1.35357 | Merckx etc. (1933) |
| 30 | 1.33749 | 1.33767 | 1.33934 | 1.33933 | 1.34257 | 1.34326 | 1.34565 | 1.34667 | „ |
| $\frac{dn}{dt}$ | 0.00044 | 46 | 45 | 46 | 46 | 47 | 47 | 47 | „ |
| 15 | 1.34431 | — | — | 1.34643 | 1.34963 | — | 1.35305 | — | Ewert (1937) |
| 15 | 1.34433 | — | — | 1.34640 | 1.34974 | — | 1.35306 | — | Joukovsky (1934) |
| 20 | — | — | 1.3438 | — | — | — | — | — | Cowley and Partington (1935) |

## PROPIONITRILE $C_2H_5CN$

**Constants:** B.E. (1934)

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 291°2–291°3 | 0.2401 | Ter Gazarian (1906) |

*Saturated vapour pressure:* I HEIM (1933) and II DREISBACH and SHRADER (1949)

| | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|
| I | 20.10 | 37.4 | 49.99 | 145.2 | 79.80 | 436.2 | 109.86 | 109.79 |
| | 24.55 | 46.7 | 55.32 | 180.5 | 85.34 | 525.2 | 114.87 | 126.32 |
| | 29.85 | 59.9 | 60.00 | 215.4 | 90.20 | 612.8 | 120.74 | 147.56 |
| | 34.48 | 74.5 | 65.88 | 268.3 | 94.61 | 702.6 | | |
| | 39.47 | 92.8 | 70.30 | 315.0 | 99.93 | 823.4 | | |
| | 45.19 | 119.4 | 75.16 | 373.3 | 104.85 | 951.5 | | |
| II | 35.5 | 75.86 | 45.76 | 123.76 | 70.45 | 315.52 | 84.44 | 507.50 |

*Boiling point*

| | | | |
|---|---|---|---|
| 97°13 | HEIM (1933) | 97°17 | MERCKX, VERHULST and BRUYLANTS (1933) |
| 97°14 | GROVES and SUGDEN (1937) | 97°20 | $\frac{dt}{dp}$ *(10 mm)*: 0°43 B.E. (1934) and LECAT |
| 97°15 | SCHIFF (1886) | 97°35 | „ 0.°4379 DREISBACH and MARTIN (1949) |
| 97°16 | LOUGUININE (1900) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −91°4 | JOUKOVSKY (1934) | −91°9 | B.E. (1934) |
| −91°85 | TIMMERMANS (1923) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.78673 | B.E. (1934) | 0 | 0.80199 | MERCKX, VERHULST and BRUYLANTS (1933) |
| 0 | 0.80200 | TIMMERMANS (1923) | | | |
| 0 | 0.8020 | TER GAZARIAN (1906) | 15 | 0.78673 | „ |
| 20 | 0.78182 | DREISBACH and MARTIN | 30 | 0.77163 | „ |
| 25 | 0.77682 | „ (1949) | 25 | 0.7770 | WALDEN (1908) |
| 30 | 0.77152 | DARAGAN (1935) | 50 | 0.7515 | „ |
| 40.83 | 0.76010 | „ | 70.15 | 0.72930 | DARAGAN (1935) |
| 40.88 | 0.76019 | „ | 70.20 | 0.72924 | „ |
| 49.75 | 0.75070 | „ | 79.80 | 0.71892 | „ |
| 49.90 | 0.75075 | „ | 80.35 | 0.71830 | „ |
| 58.60 | 0.74141 | „ | 90.15 | 0.70768 | „ |
| 60.05 | 0.74008 | „ | 90.95 | 0.70702 | „ |
| | | | 99.15 | 0.69837 | „ |

$dt = 0.80200 - 101.7.10^{-5}\ t° - 48.3.10^{-8}\ t°^2$ TIMMERMANS (1923)

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 454 | B.E. (1934) |
| 30 | 389 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.36607 | 1.36641 | — | 1.36830 | 1.37187 | 1.37275 | 1.37557 | — | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00044 | 45 | — | 45 | 45 | 45 | 45 | — | „ |
| 15 | 1.36604 | 1.36629 | 1.36812 | 1.36826 | 1.37171 | 1.37257 | 1.37521 | 1.37620 | Merckx, etc. (1933) |
| 30 | 1.35930 | 1.35958 | 1.36132 | 1.36136 | 1.36483 | 1.36562 | 1.36819 | 1.36923 | „ |
| $\frac{dn}{dt}$ | 0.00045 | 45 | 45 | 46 | 46 | 46 | 47 | 46 | „ |
| 20 | 1.36400 | 1.36425 | 1.36585 | 1.36596 | 1.36943 | 1.37025 | 1.37289 | 1.37390 | Daragan (1935) |

## *n*-BUTYRONITRILE $n$-$C_3H_7CN$

**Constants:** B.E. (1934)

*Saturated vapour pressure:* Heim (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 20.40 | 15.2 | 55.10 | 85.0 | 85.20 | 276.3 | 114.85 | 708.5 |
| 25.06 | 18.6 | 59.86 | 104.5 | 90.10 | 327.6 | 120.59 | 834.4 |
| 30.54 | 26.7 | 65.02 | 128.2 | 95.24 | 388.3 | 125.40 | 948.2 |
| 35.04 | 32.0 | 70.65 | 160.0 | 99.65 | 447.6 | 129.93 | 1070.6 |
| 40.05 | 42.5 | 75.12 | 186.8 | 104.90 | 525.7 | 135.00 | 1224.1 |
| 45.04 | 54.5 | 79.96 | 229.5 | 110.10 | 617.6 | 141.85 | 1457.6 |
| 49.90 | 67.6 | | | | | | |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 117°28 | $\frac{dt}{dp}$ *(10 mm):* 0°46 Heine (1933) | −111°9 | B.E. (1934) |
| 117°55 | Merckx, Verhulst and Bruylants (1933) | −112° | Joukovsky (1934) |
| 117°9 | Lecat | | |
| 117°94 | $\frac{dt}{dp}$ *(10 mm):* 0°47 B.E. (1934) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.80912 | B.E. (1934) | 30 | 0.78165 | Daragan (1935) |
| 15 | 0.79544 | „ | 40.55 | 0.77159 | „ |
| 30 | 0.78183 | „ | 50.20 | 0.76232 | „ |
| 0 | 0.80919 | Merckx, Verhulst and Bruylants (1933) | 60.55 | 0.75218 | „ |
| | | | 68.00 | 0.74385 | „ |
| 15 | 0.79542 | „ | 79.85 | 0.73314 | „ |
| 30 | 0.78172 | „ | 87.65 | 0.72545 | „ |
| | | | 95.60 | 0.71762 | „ |

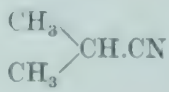
*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 624 | B.E. (1934) |
| 30 | 515 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.38382 | 1.38422 | — | 1.38623 | 1.38988 | 1.39090 | 1.39376 | — | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00041 | 43 | — | 42 | 41 | 42 | 43 | — | „ |
| 15 | 1.38373 | 1.38394 | 1.38600 | 1.38617 | 1.38965 | 1.39063 | 1.39344 | 1.39429 | Merckx, etc. (1933) |
| 30 | 1.37737 | 1.37760 | 1.37954 | 1.37967 | 1.38329 | 1.38405 | 1.38685 | 1.38795 | „ |
| $\frac{dn}{dt}$ | 0.00042 | 42 | 43 | 43 | 42 | 44 | 44 | 42 | „ |
| 20 | 1.38163 | 1.38183 | 1.38385 | 1.38402 | 1.38755 | 1.38844 | 1.39124 | 1.39218 | Daragan (1935) |
| 20 | — | — | 1.3842 | — | — | — | — | — | Dorinson and Ralston (1944) |
| 25 | — | — | 1.3820 | — | — | — | — | — | |
| 30 | — | — | 1.3798 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00044 | — | — | — | — | — | „ |

## *Iso*-BUTYRONITRILE



**Constants:** B.E. (1934)

*Boiling point*

| | | |
|---|---|---|
| 103°7 | De Hoffmann and Barbier (1936) | |
| 103°85 | $\frac{dt}{dp}$ *(10 mm)*: 0°46 | B.E. (1934) and Lecat |

*Freezing point*

| | |
|---|---|
| −71°5 | B.E. (1934) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.78942 | B.E. (1934) | 15 | 0.77525 | De Hoffmann and Barbier |
| 15 | 0.77511 | „ | 20 | 0.77037 | „ (1936) |
| 30 | 0.76082 | „ | 30 | 0.76060 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 551 | B.E. (1934) |
| 30 | 456 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 25.48 | B.E. (1934) |
| 20 | 24.93 | „ |
| 30 | 23.84 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.37354 | 1.37386 | 1.37563 | 1.37584 | 1.37942 | 1.38046 | 1.38324 | — | B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00044 | 43 | — | 43 | 43 | 44 | 44 | — | „ |
| 15 | — | 1.37365 | 1.37553 | — | — | 1.38003 | — | 1.38356 | De Hoffmann and Barbier (1936) |
| 30 | — | 1.36724 | 1.36904 | — | — | 1.37353 | — | 1.37685 | „ |
| $\frac{dn}{dt}$ | — | 43 | 43 | — | — | 43 | — | — | „ |

## *n*-VALERONITRILE $n$-$C_4H_9CN$

**Constants:** B.E. (1934)

*Saturated vapour pressure:* Heim (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 20.20 | 5.4 | 79.84 | 105.0 | 110.02 | 304.0 | 140.81 | 761.2 |
| 30.11 | 10.2 | 85.10 | 128.8 | 115.42 | 363.3 | 145.28 | 858.8 |
| 40.33 | 17.4 | 90.45 | 157.5 | 120.20 | 421.2 | 150.19 | 977.4 |
| 50.17 | 28.4 | 95.12 | 186.1 | 125.30 | 489.6 | 155.35 | 1100.8 |
| 60.06 | 45.1 | 100.34 | 223.3 | 130.00 | 561.7 | 159.95 | 1249.5 |
| 70.30 | 70.5 | 105.01 | 257.8 | 135.00 | 648.5 | 166.48 | 1458.8 |
| 75.15 | 86.8 | | | | | | |

*Boiling point*

| | |
|---|---|
| 140°75 | Lievens (1924) |
| 140°75 | $\frac{dt}{dp}$ *(10 mm):* 0°51 Heim (1933) |
| 140°80 | „ 0°49 B.E. (corr. B.E. (1934)) |
| 141°3 | Lecat |

*Freezing point*

| | |
|---|---|
| −96°0 | B.E. (1934) |
| −96° | Joukovsky (1934) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.81625 | B.E. (1934) | 30.00 | 0.79055 | Daragan (1935) |
| 15 | 0.80350 | „ | 40.40 | 0.78133 | „ |
| 30 | 0.79087 | „ | 49.40 | 0.77315 | „ |
| 0 | 0.81627 | Ewert (unpubl.) | 59.45 | 0.76409 | „ |
| 15 | 0.80345 | „ | 69.25 | 0.75532 | „ |
| 30 | 0.79053 | „ | 79.45 | 0.74589 | „ |
| 0 | 0.81636 | Merckx, etc. (1933) | 88.75 | 0.73740 | „ |
| 15 | 0.80348 | „ | 99.05 | 0.72785 | „ |
| 30 | 0.79062 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 779 |
| 30 | 637 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 28.01 |
| 20 | 27.44 |
| 30 | 26.33 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.39706 | 1.39735 | — | 1.39950 | 1.40338 | 1.40436 | 1.40736 | — | corr. B.E. (1934) |
| $\frac{dn}{dt}$ | 0.00041 | 41 | — | 40 | 40 | 41 | 43 | — | ,, |
| 15 | 1.39712 | — | — | 1.39957 | 1.40345 | — | 1.40743 | — | Ewert (unp.) |
| 15 | 1.39701 | 1.39720 | 1.39913 | 1.39930 | 1.40318 | 1.40398 | 1.40692 | 1.40793 | Merckx, etc. (1933) |
| 30 | 1.39081 | 1.39117 | 1.39307 | 1.39318 | 1.39701 | 1.39790 | 1.40067 | 1.40180 | ,, |
| $\frac{dn}{dt}$ | 0.00041 | 40 | 40 | 40 | 41 | 40 | 41 | 40 | ,, |
| 20 | 1.39497 | 1.39519 | 1.39711 | 1.39725 | 1.40113 | 1.40195 | 1.40487 | 1.40589 | Daragan (1935) |
| 20 | — | — | 1.3972 | — | — | — | — | — | Dorinson and Ralston (1944) |
| 25 | — | — | 1.3950 | — | — | — | — | — | ,, |
| 30 | — | — | 1.3929 | — | — | — | — | — | ,, |
| $\frac{dn}{dt}$ | — | — | 0.00043 | — | — | — | — | — | ,, |

## *Iso*-VALERONITRILE $(CH_3)_2CH.CH_2CN$

**Constants:** B.E. (1934)

*Boiling point*

| | |
|---|---|
| 130°3 | $\frac{dt}{dp}$ *(10 mm)*: 0°46 |
| 130°5 | Lecat |

*Freezing point*

| |
|---|
| −100°85 |

*Density*

| t° | d |
|---|---|
| 0 | 0.80797 |
| 15 | 0.79490 |
| 30 | 0.78188 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 850 |
| 30 | 677 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 26.53 |
| 20 | 25.93 |
| 30 | 24.89 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.39301 | 1.39331 | 1.39545 | 1.39930 | 1.40027 | 1.40348 |
| $\frac{dn}{dp}$ | 0.00042 | 42 | 43 | 43 | 43 | 44 |

## *n*-CAPRONITRILE $n\text{-}C_5H_{11}CN$

### Constants

*Saturated vapour pressure:* HEIM (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 19.90 | 2.3 | 90.20 | 71.3 | 124.95 | 246.1 | 159.88 | 692.6 |
| 30.17 | 3.9 | 94.72 | 85.3 | 129.61 | 285.2 | 165.21 | 799.1 |
| 40.26 | 6.8 | 100.15 | 105.6 | 134.90 | 337.0 | 169.95 | 901.3 |
| 50.30 | 11.7 | 105.01 | 125.1 | 140.00 | 392.6 | 175.20 | 1026.2 |
| 60.05 | 19.2 | 109.82 | 149.0 | 145.30 | 459.1 | 179.60 | 1145.4 |
| 70.43 | 30.9 | 114.70 | 176.0 | 150.00 | 524.5 | 185.5 | 1310 |
| 80.20 | 47.0 | 120.25 | 212.8 | 155.40 | 613.0 | | |

*Boiling point:* 163°32 $\frac{dt}{dp}$ (10 mm): 0°51 HEIM (1933)
163°9 LECAT
164°05 MERCKX, VERHULST and BRUYLANTS (1933)

*Freezing point:* −79°4 TIMMERMANS

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.82171 | MERCKX, VERHULST and BRUYLANTS (1933) | 49.90 | 0.78036 | DARAGAN (1935) |
| | | | 59.95 | 0.77168 | „ |
| 15 | 0.80942 | „ | 69.20 | 0.76376 | „ |
| 30 | 0.79713 | „ | 79.40 | 0.75510 | „ |
| 30.00 | 0.79704 | DARAGAN (1935) | 87.85 | 0.74807 | „ |
| 39.30 | 0.78873 | „ | 97.15 | 0.74005 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40663 | 1.40687 | 1.40892 | 1.40909 | 1.41298 | 1.41394 | 1.41692 | 1.41786 | MERCKX, etc. (1933) |
| 30 | 1.40073 | 1.40098 | 1.40298 | 1.40305 | 1.40690 | 1.40799 | 1.41087 | 1.41193 | „ |
| $\frac{dn}{dt}$ | 0.00039 | 39 | 39 | 40 | 40 | 39 | 40 | 39 | „ |
| 20 | 1.40463 | 1.40491 | 1.40694 | 1.40709 | 1.41098 | 1.41189 | 1.41492 | 1.41590 | DARAGAN (1935) |
| 20 | — | — | 1.4069 | — | — | — | — | — | DORINSON and RALSTON (1944) |
| 25 | — | — | 1.4049 | — | — | — | — | — | |
| 30 | — | — | 1.4028 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00041 | — | — | — | — | — | „ |

## *Iso*-CAPRONITRILE $(CH_3)_2CH(CH_2)_2CN$

### Constants

*Freezing point:* −51°1 TIMMERMANS

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.8038 | TURNER and MERRY (1910) |
| 30 | 0.7955 | „ |
| 45 | 0.7827 | „ |
| 60 | 0.7699 | „ |
| 14.2 | 0.8075 | EYKMAN (1893) |

*Surface tension*

| t° | γ | |
|---|---|---|
| 20 | 26.53 | TURNER and MERRY (1910) |
| 30 | 25.61 | „ |
| 45 | 24.23 | „ |
| 60 | 22.84 | „ |

## *n*-OENANTHONITRILE $n\text{-}C_6H_{13}CN$

### Constants

*Saturated vapour pressure:* HEIM (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 20.00 | 1.5 | 89.50 | 36.1 | 134.60 | 186.0 | 169.94 | 525.5 |
| 29.60 | 2.4 | 99.51 | 53.6 | 139.78 | 219.3 | 174.79 | 599.3 |
| 40.85 | 3.5 | 109.55 | 79.0 | 144.89 | 257.3 | 180.40 | 692.5 |
| 49.60 | 5.6 | 114.84 | 95.7 | 149.64 | 296.9 | 185.30 | 780.3 |
| 59.86 | 9.3 | 119.92 | 114.8 | 154.70 | 346.4 | 190.85 | 893.0 |
| 69.92 | 15.1 | 125.10 | 135.7 | 159.95 | 400.4 | 194.70 | 980.5 |
| 79.86 | 23.7 | 129.95 | 160.0 | 164.58 | 454.6 | 199.30 | 1109.2 |

*Boiling point:* 184°20 $\frac{dt}{dp}$ (10 *mm*): 0°56 HEIM (1933)

184°57 MERCKX, VERHULST and BRUYLANTS (1933)

*Density*

| t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|
| 30.00 | 0.80171 | 57.95 | 0.77866 | 88.60 | 0.75402 | DARAGAN (1937) |
| 40.12 | 0.79343 | 69.55 | 0.76922 | 98.50 | 0.74525 | „ |
| 49.75 | 0.78538 | 80.20 | 0.76047 | | | „ |
| 0 | 0.82524 | MERCKX, VERHULST and BRUYLANTS (1933) | | | | |
| 15 | 0.81348 | | | | | |
| 30 | 0.80177 | | | | | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41381 | 1.41409 | 1.41610 | 1.41626 | 1.42035 | 1.42128 | 1.42433 | 1.42545 | Merckx, Verhulst and Bruylants |
| 30 | 1.40802 | 1.40836 | 1.41037 | 1.41039 | 1.41442 | 1.41542 | 1.41837 | 1.41958 | „ (1933) |
| $\frac{dn}{dt}$ | 0.00039 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | „ |
| 20 | 1.41191 | 1.41218 | 1.41419 | 1.41431 | 1.41840 | 1.41931 | 1.42238 | 1.42349 | Daragan (1935) |
| 20 | — | — | 1.4144 | — | — | — | — | — | Dorinson and Ralston (1944) |
| 25 | — | — | 1.4124 | — | — | — | — | — | „ |
| 30 | — | — | 1.4104 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00040 | — | — | — | — | — | „ |

## Constants — *n*-CAPRYLONITRILE — $n$-$C_7H_{15}CN$

*Saturated vapour pressure:* Heim (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 20.13 | 0.3 | 100.43 | 25.1 | 144.75 | 137.4 | 180.00 | 402.9 |
| 40.25 | 0.8 | 109.98 | 37.7 | 149.50 | 160.9 | 185.10 | 461.0 |
| 50.20 | 1.7 | 120.90 | 58.9 | 155.40 | 195.9 | 190.49 | 530.1 |
| 60.30 | 3.3 | 125.60 | 70.0 | 160.61 | 228.1 | 195.42 | 603.6 |
| 70.44 | 5.8 | 130.40 | 82.8 | 164.71 | 259.2 | 200.04 | 678.7 |
| 80.35 | 9.9 | 134.91 | 97.7 | 169.89 | 301.3 | 204.58 | 760.2 |
| 89.72 | 15.8 | 139.75 | 115.9 | 175.10 | 350.3 | | |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 204°57 | $\frac{dt}{dp}$ *(10 mm):* 0°56 Heim (1933) | −45°6 | Timmermans |
| 205°2 | „ 0°57 Deffet (1931) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.82862 | Deffet (1931) | 0 | 0.82871 | Merckx, Verhulst and Bruylants (1933) |
| 15 | 0.81725 | „ | | | |
| 30 | 0.80581 | „ | 15 | 0.81739 | „ |
| | | | 30 | 0.80586 | „ |
| 30.00 | 0.80582 | Daragan (1935) | 70.90 | 0.77360 | Daragan (1935) |
| 40.83 | 0.79735 | „ | 80.05 | 0.76640 | „ |
| 49.75 | 0.79026 | „ | 90.35 | 0.75813 | „ |
| 59.55 | 0.78260 | „ | 99.15 | 0.75129 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1811 | DEFFET (1931) |
| 30 | 1336 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41975 | 1.42003 | 1.42211 | 1.42227 | 1.42628 | 1.42738 | 1.43039 | 1.43165 | MERCKX, etc. (1933) |
| 30 | 1.41405 | 1.41428 | 1.41632 | 1.41661 | 1.42070 | 1.42137 | 1.42461 | 1.42567 | „ |
| $\frac{dn}{dt}$ | 0.00038 | 38 | 39 | 38 | 37 | 40 | 38 | 39 | „ |
| 20 | 1.41789 | 1.41811 | 1.42018 | 1.42037 | 1.42443 | 1.42538 | 1.42849 | 1.42962 | DARAGAN (1935) |
| 20 | — | — | 1.4204 | — | — | — | — | — | DORINSON and RALSTON (1944) |
| 25 | — | — | 1.4183 | — | — | — | — | — | „ |
| 30 | — | — | 1.4164 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00040 | — | — | — | — | — | „ |
| 15 | 1.41980 | 1.42016 | — | 1.42240 | 1.42663 | 1.42766 | 1.43065 | 1.43187 | DEFFET (1931) |
| $\frac{dn}{dt}$ | 0.00039 | 39 | — | 40 | 40 | 41 | 40 | — | „ |

## *n*-PELARGONITRILE $n\text{-}C_8H_{17}CN$

**Constants**

*Boiling point:* 224°0 DEFFET (1931)

*Freezing point:* −34°2 DEFFET (1931)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.83181 | DEFFET (unp.) | 0 | 0.83180 | MERCKX, VERHULST and BRUYLANTS (1933) |
| 30 | 0.80944 | corr. DEFFET (1931) | | | |
| | | | 15 | 0.82061 | „ |
| 30.00 | 0.80946 | DARAGAN (1935) | 30 | 0.80947 | „ |
| 40.95 | 0.80092 | „ | 78.95 | 0.77157 | DARAGAN (1935) |
| 51.00 | 0.79321 | „ | 88.75 | 0.76402 | „ |
| 60.55 | 0.78574 | „ | 99.35 | 0.75570 | „ |
| 69.95 | 0.77860 | „ | 109.00 | 0.74831 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2340 | DEFFET (1931) |
| 30 | 1688 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42476 | 1.42497 | 1.42713 | 1.42719 | 1.43144 | 1.43243 | 1.43547 | 1.43662 | Merckx, etc. (1933) |
| 30 | 1.41909 | 1.41934 | 1.42140 | 1.42156 | 1.42579 | 1.42668 | 1.42980 | 1.43092 | „ |
| $\frac{dn}{dt}$ | 0.00038 | 37 | 39 | 37 | 38 | 39 | 38 | 39 | „ |
| 20 | 1.42288 | 1.42309 | 1.42522 | 1.42529 | 1.42954 | 1.43051 | 1.43357 | 1.43472 | Daragan (1935) |
| 20 | — | — | 1.4254 | — | — | — | — | — | Dorinson and Ralston (1944) |
| 25 | — | — | 1.4235 | — | — | — | — | — | „ |
| 30 | — | — | 1.4216 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00038 | — | — | — | — | — | „ |
| 25 | — | — | 1.4233 | — | — | — | — | — | Ralston, Selby, Pool and Potts (1940) |

## Constants

## *n*-DECANENITRILE $n$-$C_9H_{19}CN$

*Freezing point:* −14°46 Hoerr, Binkerd, Pool and Ralston (1944)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.83429 | Merckx, Verhulst and Bruylants (1933) | 60.40 | 0.78976 | Daragan (1935) |
| | | | 70.45 | 0.78249 | „ |
| 15 | 0.82332 | „ | 80.35 | 0.77504 | „ |
| 30 | 0.81240 | „ | 89.65 | 0.76778 | „ |
| 40.85 | 0.80425 | Daragan (1935) | 96.05 | 0.76126 | „ |
| 49.80 | 0.79771 | „ | 111.00 | 0.75210 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42887 | 1.42917 | 1.43129 | 1.43134 | 1.43563 | 1.43670 | 1.43980 | 1.44108 | Merckx, Verhulst and Bruylants |
| 30 | 1.42341 | 1.42365 | 1.42579 | 1.42599 | 1.43011 | 1.43101 | 1.43421 | 1.44540 | „ (1933) |
| $\frac{dn}{dt}$ | 0.00037 | 37 | 37 | 36 | 37 | 38 | 37 | 38 | „ |
| 20 | 1.42707 | 1.42726 | 1.42940 | 1.42954 | 1.43378 | 1.43480 | 1.43790 | 1.44119 | Daragan (1935) |
| 20 | — | — | 1.4296 | — | — | — | — | — | Dorinson and Ralston (1944) |
| 25 | — | — | 1.4276 | — | — | — | — | — | „ |
| 30 | — | — | 1.4256 | — | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00040 | — | — | — | — | — | „ |

## *n*-NITRILES (from $C_{11}$ to $C_{14}$)

**Constants:** I Merckx, Verhulst and Bruylants (1933)
II Daragan (1935)
III Dorinson and Ralston (1944)

### UNDECANENITRILE $n$-$C_{10}H_{21}CN$

*Density*

| I | | II | |
|---|---|---|---|
| 0° | 0.83621 | 30° | 0.81462 |
| 15° | 0.82538 | 41°00 | 0.80619 |
| 30° | 0.81465 | 49°80 | 0.79996 |
| | | 59°15 | 0.79309 |
| | | 69°60 | 0.78543 |
| | | 79°70 | 0.77798 |
| | | 88°85 | 0.77145 |
| | | 100°15 | 0.76316 |
| | | 110°80 | 0.75544 |

*Refractive index*

| | II | I | | |
|---|---|---|---|---|
| | 20° | 15° | 30° | $\frac{dn}{dt} \cdot 10^4$ |
| He r. | 1.43039 | 1.43218 | 1.42661 | 37 |
| Hα | 1.43074 | 1.43255 | 1.42713 | 36 |
| D | 1.43286 | 1.43464 | 1.42929 | 36 |
| He y. | 1.43299 | 1.43478 | 1.42935 | 36 |
| He g. | 1.43728 | 1.43903 | 1.43349 | 37 |
| Hβ | 1.43825 | 1.44007 | 1.43462 | 36 |
| He v. | 1.44145 | 1.44323 | 1.43762 | 37 |
| Hγ | 1.44254 | 1.44444 | 1.43892 | 37 |

| III | | |
|---|---|---|
| D | 1.4330 | 1.4312 (25°) | 1.4293 |

### LAURONITRILE $n$-$C_{11}H_{23}CN$

*Density*

| I | | II | |
|---|---|---|---|
| 0° | 0.83815 | 30°00 | 0.81680 |
| 15° | 0.82744 | 40°43 | 0.80918 |
| 30° | 0.81685 | 51°05 | 0.80160 |
| | | 60°60 | 0.79453 |
| | | 69°00 | 0.78838 |
| | | 79°75 | 0.78060 |
| | | 89°35 | 0.77368 |
| | | 96°05 | 0.76676 |
| | | 109°80 | 0.75905 |

*Refractive index*

| | II | I | | |
|---|---|---|---|---|
| | | | | |
| He r. | 1.43346 | 1.43526 | 1.42985 | 36 |
| Hα | 1.43378 | 1.43558 | 1.43022 | 36 |
| D | 1.43595 | 1.43774 | 1.43240 | 35 |
| He y. | 1.43610 | 1.43785 | 1.43256 | 35 |
| He g. | 1.44030 | 1.44220 | 1.43663 | 37 |
| Hβ | 1.44137 | 1.44323 | 1.43766 | 37 |
| He v. | 1.44450 | 1.44640 | 1.44081 | 37 |
| Hγ | 1.44586 | 1.44776 | 1.44206 | 38 |

| III | | |
|---|---|---|
| D | 1.4360 | 1.4341 (25°) | 1.4322 |

### TRIDECANENITRILE $n$-$C_{12}H_{25}CN$

*Density*

| I | | II | |
|---|---|---|---|
| 15° | 0.82937 | 30°08 | 0.81875 |
| 30° | 0.81887 | 40°15 | 0.81130 |
| | | 49°30 | 0.80491 |
| | | 60°17 | 0.79700 |
| | | 69°85 | 0.79032 |
| | | 80°15 | 0.78297 |
| | | 89°85 | 0.77596 |
| | | 100°15 | 0.76879 |
| | | 111°05 | 0.76098 |

*Refractive index*

| | II | I | | |
|---|---|---|---|---|
| | | | | |
| He r. | 1.43615 | 1.43793 | 1.43257 | 36 |
| Hα | 1.43653 | 1.43835 | 1.43289 | 36 |
| D | 1.43867 | 1.44045 | 1.43512 | 36 |
| He y. | 1.42873 | 1.44056 | 1.43518 | 36 |
| He g. | 1.44303 | 1.44499 | 1.43932 | 37 |
| Hβ | 1.44417 | 1.44605 | 1.44040 | 37 |
| He v. | 1.44736 | 1.44933 | 1.44362 | 37 |
| Hγ | 1.44862 | 1.45048 | 1.44492 | 37 |

| III | | |
|---|---|---|
| D | 1.4384 | 1.4368 25° | 1.4349 |

| (continued) | Density | | | | Refractive index | | | |
|---|---|---|---|---|---|---|---|---|
| MYRISTONITRILE $n$-$C_{13}H_{27}CN$ | I | | II | | | II | I | |
| | | | | | | 20° | 15° | 30° |
| | 30° | 0.82065 | 42°91 | 0.81188 | He r. | 1.43854 | — | 1.43487 |
| | | | 49°85 | 0.80683 | Hα | 1.43923 | — | 1.43522 |
| | | | 59°60 | 0.80000 | D | 1.44126 | — | 1.43741 |
| | | | 69°65 | 0.79291 | He y. | 1.44137 | — | 1.43741 |
| | | | 81°10 | 0.78486 | He g. | 1.44568 | — | 1.44174 |
| | | | 89°55 | 0.77873 | Hβ | 1.44682 | — | 1.44289 |
| | | | 100°72 | 0.77080 | He v. | 1.45004 | — | 1.44601 |
| | | | 109°95 | 0.76431 | Hγ | 1.45129 | — | 1.44735 |
| | | | 120°60 | 0.75638 | | | | |
| | | | 132°50 | 0.74817 | | | III | |
| | | | | | D | 1.4410 | 1.4392 (25°) | 1.4373 |

PENTADECANENITRILE: $n$-$C_{14}H_{29}CN$
PALMITONITRILE: $n$-$C_{15}H_{31}CN$
MARGARONITRILE: $n$-$C_{16}H_{33}CN$
STEARONITRILE: $n$-$C_{17}H_{35}CN$
*Refractive index:* Dorinson and Ralston (1944)

## METHYL $n$-NITRILES (from $C_5$ to $C_{15}$) $RCH(CH_3)CN$

**Constants:** De Hoffmann and Barbier (1936)

| | B.P. | Density | | Refractive index | | | |
|---|---|---|---|---|---|---|---|
| | | 15° | 30° | | 15° | 30° | $\frac{dn}{dt}$ |
| R = $n$-$C_2H_5$ | 125°4 | 0.79128 | 0.77780 | Hα | 1.38998 | 1.38370 | 0.00042 |
| | | | | D | 1.39195 | 1.38562 | 42 |
| | | | | Hβ | 1.39667 | 1.39021 | 43 |
| | | | | Hγ | 1.40042 | 1.39417 | 43 |
| R = $n$-$C_3H_7$ | 147°1 | 0.79747 | 0.78472 | Hα | 1.40001 | 1.39387 | 41 |
| | | | | D | 1.40204 | 1.39588 | 41 |
| | | | | Hβ | 1.40688 | 1.40058 | 42 |
| | | | | Hγ | 1.41070 | 1.40439 | 42 |
| R = $n$-$C_4H_9$ | 164°7 | 0.80384 | 0.79169 | Hα | 1.40842 | 1.40266 | 38 |
| | | | | D | 1.41046 | 1.40467 | 38 |
| | | | | Hβ | 1.41545 | 1.40965 | 39 |
| | | | | Hγ | 1.41941 | 1.41345 | 39 |

| (continued) | *B.P.* | *Density* | | *Refractive index* | | | |
|---|---|---|---|---|---|---|---|
| | | 15° | 30° | | 15° | 30° | $\frac{dn}{dt}$ |
| R = *n*-$C_5H_{11}$ | 184·7 | 0.80823 | 0.79644 | Hα | 1.41469 | 1.40906 | 0.00037 |
| | | | | D | 1.41680 | 1.41121 | 37 |
| | | | | Hβ | 1.42187 | 1.41616 | 38 |
| | | | | Hγ | 1.42585 | 1.42007 | 38 |
| R = *n*-$C_6H_{13}$ | — | 0.81214 | 0.80074 | Hα | 1.42020 | 1.41466 | 37 |
| | | | | D | 1.42226 | 1.41675 | 37 |
| | | | | Hβ | 1.42745 | 1.42184 | 37 |
| | | | | Hγ | 1.43165 | 1.42599 | 38 |
| R = *n*-$C_7H_{15}$ | — | 0.81561 | 0.80442 | Hα | 1.42452 | 1.41937 | 34 |
| | | | | D | 1.42669 | 1.42145 | 35 |
| | | | | Hβ | 1.43191 | 1.42646 | 36 |
| | | | | Hγ | 1.43591 | 1.43046 | 36 |
| R = *n*-$C_8H_{17}$ | — | 0.81851 | 0.80757 | Hα | 1.42840 | 1.42310 | 35 |
| | | | | D | 1.43057 | 1.42543 | 34 |
| | | | | Hβ | 1.43588 | 1.43046 | 36 |
| | | | | Hγ | 1.44008 | 1.43473 | 36 |
| R = *n*-$C_9H_{19}$ | — | 0.82128 | 0.81031 | Hα | 1.43171 | 1.42633 | 36 |
| | | | | D | 1.43387 | 1.42843 | 36 |
| | | | | Hβ | 1.43920 | 1.43374 | 36 |
| | | | | Hγ | 1.44349 | 1.43790 | 37 |
| R = *n*-$C_{10}H_{21}$ | — | 0.82380 | 0.81316 | Hα | 1.43443 | 1.42923 | 35 |
| | | | | D | 1.43669 | 1.43150 | 35 |
| | | | | Hβ | 1.44205 | 1.43668 | 36 |
| | | | | Hγ | 1.44647 | — | — |
| R = *n*-$C_{12}H_{25}$ | — | 0.82765 | 0.81707 | Hα | 1.43931 | 1.43389 | 36 |
| | | | | D | 1.44152 | 1.43618 | 36 |
| | | | | Hβ | 1.44696 | 1.44145 | 37 |
| | | | | Hγ | 1.45117 | — | — |

ACRYLONITRILE: $CH_2$=CH.CN: *Saturated vapour pressure, boiling* and *melting points, density, refractive index, specific heat* and *heat of combustion:* Davis and Wiedeman (1945).

## CROTONITRILE $CH_3.CH=CH.CN$ *cis*

**Constants** — *Saturated vapour pressure:* Heim (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 24.95 | 31.8 | 55.09 | 125.1 | 84.70 | 374.1 | 114.32 | 926.7 |
| 29.85 | 40.6 | 60.05 | 150.6 | 89.70 | 440.9 | 120.30 | 1091.7 |
| 34.85 | 51.7 | 64.79 | 182.1 | 94.62 | 516.1 | 124.58 | 1211.3 |
| 40.23 | 66.1 | 69.65 | 219.3 | 99.99 | 606.1 | 131.79 | 1464.7 |
| 44.83 | 81.2 | 74.85 | 266.3 | 104.97 | 706.1 | | |
| 49.84 | 100.4 | 79.80 | 316.0 | 109.85 | 814.3 | | |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 107°47 | $\frac{dt}{dp}$ *(10 mm)*: 0°46 HEIM (1933) | −72°1 | TIMMERMANS (passim) |
| 107°77 | BRUYLANTS and CHRISTIAEN (1925) | | |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.84376 | HEIM (1933) |
| 15 | 0.82890 | „ |
| 30 | 0.81402 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.41683 | 1.41736 | 1.42065 | 1.42072 | 1.42718 | 1.42887 | 1.43376 | 1.43590 | HEIM (1933) |
| 30 | 1.40968 | 1.41021 | 1.41335 | 1.41343 | 1.41982 | 1.42142 | 1.42633 | 1.42852 | „ |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 48 | 48 | 49 | 50 | 50 | 49 | „ |

| *Heat of combustion* | 20°, ($c_v$) 8516.1 cal 15°/g | BRUYLANTS and CHRISTIAEN (1925) |
|---|---|---|

## *Iso*-CROTONITRILE $CH_3.CH{=}CH.CN$ *trans*

**Constants**

*Saturated vapour pressure:* HEIM (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 19.20 | 12.3 | 54.36 | 71.0 | 89.80 | 279.7 | 124.79 | 811.9 |
| 25.12 | 17.3 | 59.49 | 88.2 | 94.99 | 332.4 | 130.85 | 960.1 |
| 29.62 | 22.0 | 65.18 | 111.7 | 99.95 | 390.4 | 135.95 | 1098.6 |
| 34.25 | 27.8 | 69.90 | 134.5 | 104.87 | 454.6 | 140.67 | 1241.1 |
| 40.05 | 37.3 | 74.89 | 163.5 | 109.45 | 524.5 | 146.06 | 1421.6 |
| 44.65 | 45.9 | 79.80 | 196.3 | 114.55 | 611.1 | | |
| 50.07 | 59.0 | 84.79 | 234.6 | 119.52 | 704.6 | | |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 121°23 | BRUYLANTS and CHRISTIAEN (1925) | −51°1 | TIMMERMANS (passim) |
| 122°31 | $\frac{dt}{dp}$ *(10 mm)*: 0°50 HEIM (1933) | | |

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.84046 | Heim (1933) |
| 15 | 0.82586 | „ |
| 30 | 0.81135 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.42097 | 1.42140 | 1.42488 | 1.42490 | 1.43180 | 1.43337 | 1.43877 | 1.44074 | Heim (1933) |
| 30 | 1.41400 | 1.41438 | 1.41775 | 1.41791 | 1.42460 | 1.42617 | 1.43146 | 1.43349 | „ |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 48 | 47 | 48 | 48 | 48 | 49 | „ |

| *Heat of combustion* | 20°, ($c_v$) 8544.8 cal 15°/g | Bruylants and Christiaen (1925) |
|---|---|---|

## VINYLACETONITRILE $CH_2=CH.CH_2.CN$

### Constants

*Saturated vapour pressure:* Heim (1933)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 15.37 | 10.8 | 49.51 | 62.3 | 84.78 | 258.8 | 120.10 | 797.2 |
| 20.52 | 14.2 | 55.06 | 79.9 | 89.88 | 309.2 | 125.30 | 921.0 |
| 25.03 | 18.2 | 60.27 | 99.9 | 94.62 | 363.4 | 130.10 | 1047.6 |
| 29.65 | 23.5 | 65.84 | 125.3 | 99.87 | 431.7 | 134.86 | 1191.2 |
| 34.75 | 30.7 | 70.81 | 153.4 | 104.65 | 500.5 | 139.60 | 1349.5 |
| 39.85 | 39.8 | 74.94 | 179.7 | 109.94 | 589.7 | 143.46 | 1489.2 |
| 45.22 | 51.2 | 79.99 | 217.2 | 115.45 | 697.2 | | |

*Boiling point*

| | |
|---|---|
| 118°42 | $\frac{dt}{dp}$ *(10 mm):* 0°45 Heim (1933) |
| 118°52 | Bruylants and Christiaen (1925) |

*Density*

| t | d | |
|---|---|---|
| 0 | 0.85286 | Heim (1933) |
| 15 | 0.83823 | „ |
| 30 | 0.82372 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.40522 | 1.40572 | 1.40819 | 1.40829 | 1.41324 | 1.41454 | 1.41822 | 1.41983 | Heim (1933) |
| 30 | 1.39863 | 1.39900 | 1.40147 | 1.40158 | 1.40645 | 1.40766 | 1.41137 | 1.41290 | „ |
| $\frac{dn}{dt}$ | 0.00044 | 45 | 45 | 45 | 46 | 46 | 46 | 46 | „ |

| | | |
|---|---|---|
| *Heat of combustion* | 20°, ($c_v$) 8561.3 cal 15°/g | Bruylants and Christiaen (1925) |

## PENTENE(4)NITRILES $CH_2=CH.(CH_2)_2.CN$

**Constants:** Vandewyer (1935)

*Boiling point: cis:* 128°0; *trans:* 145°5

*Density*

| | | | | |
|---|---|---|---|---|
| *cis* | 15° | 0.82464 | 30° | 0.81063 |
| *trans* | 15° | 0.82814 | 30° | 0.81586 |

*Refractive index:*

| | *cis* | | | | *trans* | | | |
|---|---|---|---|---|---|---|---|---|
| t° | Hα | D | Hβ | Hγ | Hα | D | Hβ | Hγ |
| 15 | 1.42376 | 1.42703 | 1.43491 | 1.44162 | 1.43073 | 1.43396 | 1.44228 | 1.44949 |
| 20 | 1.42166 | 1.42473 | 1.43275 | 1.43949 | — | — | — | — |
| 30 | 1.41740 | 1.40050 | 1.42834 | 1.43492 | 1.42450 | 1.42753 | 1.43587 | 1.44290 |
| $\frac{dn}{dt}$ | 0.00042 | 43 | 44 | 45 | 0.00042 | 43 | 43 | 44 |

## HEXENE(5)NITRILES $CH_2=CH.(CH_2)_3.CN$

**Constants:** Vandewyer (1935)

*Boiling point: cis:* 150°5; *trans:* 165°94

*Density*

| | | | | | | |
|---|---|---|---|---|---|---|
| *cis* | 15° | 0.82819 | 20° | 0.82399 | 30° | 0.81539 |
| *trans* | 15° | 0.82910 | 20° | 0.82470 | 30° | 0.81604 |

*Refractive index:*

| | *cis* | | | | *trans* | | | |
|---|---|---|---|---|---|---|---|---|
| t° | Hα | D | Hβ | Hγ | Hα | D | Hβ | Hγ |
| 15 | 1.43073 | 1.43321 | 1.44148 | 1.44802 | 1.43563 | 1.43884 | 1.44681 | 1.45354 |
| 20 | 1.42861 | 1.43128 | 1.43934 | 1.44585 | 1.43342 | 1.43659 | 1.44454 | 1.45122 |
| 30 | 1.42436 | 1.42703 | 1.43507 | 1.44150 | 1.42901 | 1.43213 | 1.43999 | 1.44659 |
| $\frac{dn}{dt}$ | 0.00042 | 41 | 43 | 43 | 0.00044 | 45 | 45 | 46 |

## HEPTENE(6)NITRILES $CH_2=CH.(CH_2)_4.CN$

**Constants:** DE HOFFMANN and BARBIER (1935) *cis*
DE HOFFMAN (1935) *trans*

*Density*

| | | | | | |
|---|---|---|---|---|---|
| 15° | 0.82960 | *cis* | 30° | 0.81754 | *cis* |
| 15° | 0.83088 | *trans* | 30° | 0.81875 | *trans* |

*Refractive index*

| | *cis* | | | | *trans* | | | |
|---|---|---|---|---|---|---|---|---|
| t° | Hα | D | Hβ | Hγ | Hα | D | Hβ | Hγ |
| 15 | 1.43543 | 1.43849 | 1.44596 | 1.45226 | 1.43978 | 1.44292 | 1.45067 | 1.45719 |
| 30 | 1.42912 | 1.43205 | 1.43945 | 1.44555 | 1.43369 | 1.43668 | 1.44437 | 1.45082 |
| $\frac{dn}{dt}$ | 0.00042 | 43 | 43 | 44 | 0.00041 | 42 | 42 | 42 |

## OCTENE(7)NITRILE (*cis*) $CH_2=CH.(CH_2)_5.CN$

(with the lower boiling point)

**Constants:**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 15 | 0.83236 | VANDEWYER (1935) | 20 | 0.82854 | BRUYLANTS and FONTEYN (1933) |
| 20 | 0.82842 | „ | | | |
| 30 | 0.82062 | „ | | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 15 | 1.43991 | 1.44284 | 1.45029 | 1.45658 | VANDEWYER (1935) |
| 20 | 1.43788 | 1.44079 | 1.44824 | 1.45453 | „ |
| 30 | 1.43409 | 1.43693 | 1.44428 | 1.45047 | „ |
| $\frac{dn}{dt}$ | 0.00039 | 39 | 40 | 41 | „ |
| 20 | 1.43749 | 1.44032 | 1.44777 | — | BRUYLANTS and FONTEYN (1933–34) |

## CITRACONITRILE (*cis*) and MESACONITRILE (*trans*)
## $CN.C(CH_3)=CH.CN$

**Constants:** Van de Straete (1935)

| | *cis* | | | | *trans* | | | |
|---|---|---|---|---|---|---|---|---|
| | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
| *Saturated vapour pressure* | 122 | 11.5 | 172 | 86.5 | 66 | 10 | 117 | 102 |
| | 128 | 15 | 179.5 | 113 | 71 | 13 | 119.5 | 112 |
| | 150.5 | 41 | 189 | 160.5 | 88.5 | 32 | 124 | 181 |
| | 157.5 | 51.5 | 194 | 184 | 96.5 | 43.5 | 134 | 189 |
| | | | | | 100 | 52.5 | 138 | 227 |
| | | | | | 104 | 62.5 | | |
| *Melting point* | 106°3–106°5 | | | | — | | | |
| *Density* | 107° | | 1.1571 | | 15° | 0.98221 | 106°15 | 0.8941 |
| | 109°6 | | 1.1560 | | 30° | 0.96797 | 116°1 | 0.8836 |
| | 115°25 | | 1.1534 | | | | | |
| *Refractive index* | 110°7 | | | | 15° | 30° | $\frac{dn}{dt}$ | 110°7 |
| | Hα | 1.47975 | | | 1.46551 | 1.45941 | 0.00041 | 1.42169 |
| | D | 1.48420 | | | 1.46985 | 1.46367 | 41 | 1.42565 |
| | Hβ | 1.49571 | | | 1.48107 | 1.47453 | 43 | 1.43568 |

## CYANOGEN or OXALONITRILE $C_2N_2$

**Constants**

*Critical constants*

| t° cr. | p cr. | |
|---|---|---|
| 126°55 | 58.2 atm. | Terwen (1916) |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. −71.58 | 18.0 | −51.80 | 100.6 | −34.67 | 354.8 | Terwen (1916) |
| −68.79 | 24.5 | −49.31 | 122.4 | −32.16 | 420.3 | „ |
| −65.97 | 31.0 | −46.82 | 147.9 | −29.65 | 498.0 | „ |
| −63.49 | 38.7 | −43.98 | 182.9 | −28.93 | 520.7 | „ |
| −61.02 | 47.4 | −42.18 | 208.0 | −28.57 | 533.8 | „ |
| −57.83 | 62.0 | −39.68 | 248.6 | −28.22 | 546.0 | „ |
| −54.99 | 77.6 | −37.18 | 297.7 | | | „ |

*Saturated vapour pressure* (continued)

| | t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|---|
| C. | −93.16 | 1.7 | −60.69 | 47.53 | −35.28 | 336.4 | Perry and Bardwell |
| | −83.40 | 5.65 | −49.02 | 123.2 | −33.18 | 390.9 | „ (1925) |
| | −74.05 | 12.79 | −42.83 | 196.7 | −32.31 | 412.9 | „ |
| | −69.24 | 22.29 | | | | | „ |
| L. | −27.17 | 572.6 | −14.84 | 1007.4 | −9.60 | 1250.7 | „ |
| | −25.19 | 629.8 | −13.07 | 1086.4 | −7.13 | 1387.4 | „ |
| | −21.33 | 754.0 | −11.28 | 1171.5 | −7.12 | 1388.4 | „ |
| | −17.75 | 886.4 | | | | | „ |

| | t° | p atm. | t° | p atm. | t° | p atm. | |
|---|---|---|---|---|---|---|---|
| L. | 1.40 | 2.54 | 62.15 | 15.75 | 87.7 | 28.10 | Terwen (1916) |
| | 5.00 | 2.89 | 62.55 | 15.90 | 104.5 | 38.5 | „ |
| | 8.24 | 3.26 | 65.9 | 17.22 | 110.3 | 43.2 | „ |
| | 9.97 | 3.46 | 69.6 | 18.72 | 117.45 | 49.3 | „ |
| | 11.12 | 3.58 | 69.9 | 18.82 | 120.05 | 51.5 | „ |
| | 42.10 | 9.64 | 70.6 | 19.28 | 123.45 | 54.7 | „ |
| | 43.8 | 9.85 | 75.5 | 21.35 | 125.4 | 56.8 | „ |
| | 49.5 | 11.51 | 77.0 | 22.19 | 125.6 | 57.15 | „ |
| | 51.8 | 12.17 | 78.15 | 22.75 | 126.2 | 57.6 | „ |
| | 58.25 | 14.30 | 79.75 | 23.53 | 126.3 | 57.9 | „ |
| | 59.7 | 14.79 | 84.25 | 26.09 | | | „ |

*Boiling point*

| | |
|---|---|
| −21°15 | Perry and Bardwell (1925) |
| −21°35 | Terwen (1916) |

*Freezing point*

| | | |
|---|---|---|
| *Form I* | −27°92 | Terwen (1916) |
| *Form II* | −27°05 | „ |

## METHYLENE DICYANIDE or MALONITRILE $CN.CH_2.CN$

**Constants**

*Melting point:* 31°65 Van de Vloed (1938)

*Density*

| t° | d | |
|---|---|---|
| 32.7 | 1.0506 | Walden and Swinne |
| 50.0 | 1.0338 | „ (1912) |
| 70.0 | 1.0149 | „ |
| 107.0 | 1.0794 | „ |
| 35.0 | 1.04873 | Van de Vloed (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 32.68 | 2850 | Walden and Swinne |
| 50.0 | 2150 | „ (1912) |

## ETHYLENE DICYANIDE or SUCCINONITRILE $CN.CH_2.CH_2.CN$

Purified by fractional distillation under reduced pressure in the presence of $P_2O_5$. The criterion of purity is the constancy of the freezing point and the density for successive fractions.

**Constants:** B.E. (1937)

*Melting point*

| | | | |
|---|---|---|---|
| 56°6 | Meerman (1943) | 57°15 | Van de Vloed (1938) |
| 56°9 | Deffet (1940) | 57°15–57°20 | B.E. (1937) |

*Melting curve*

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 56.9 | 1 | Deffet (1940) | 70.0 | 666 | Deffet (1940) |
| 64.0 | 364 | „ | 75.0 | 921 | „ |
| 67.0 | 516 | „ | | | |

*Density*

| *Dilatometre* | | *Picnometre* | | |
|---|---|---|---|---|
| t° | d | t° | d | |
| 60 | 0.98669 | 60 | 0.98680 | B.E. (1937) |
| 70 | 0.97860 | | | „ |
| 80 | 0.97059 | | | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 60 | 2591 |
| 75 | 2008 |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 60 | 46.78 | |
| 70 | 45.72 | |
| 80 | 44.62 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|---|
| 60 | 1.41496 | 1.41525 | 1.41734 | 1.41751 | 1.42170 | 1.42267 | 1.42590 |
| $\frac{dn}{dt}$ | 0.00038 | 37 | — | 37 | 38 | 39 | 38 |

## TRIMETHYLENE DICYANIDE or GLUTARONITRILE
## $CN . CH_2 . CH_2 . CH_2 . CN$

**Constants:** SERWY (1933)

*Freezing point*

| | | | | | |
|---|---|---|---|---|---|
| *Form α* | 29·45 | TIMMERMANS (passim) | *Form β* | −32·4 | VAN DE VLOED (1938) |

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.00293 | SERWY (1933) |
| 15 | 0.99112 | „ |
| 30 | 0.9730 | „ |
| 0 | 1.00291 | VAN DE VLOED (1938) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 8104 | SERWY (1933) |
| 30 | 5226 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.43426 | 1.43461 | 1.43699 | 1.44137 | 1.44242 | 1.44573 | 1.45048 |
| $\frac{dn}{dt}$ | 0.00035 | 35 | 35 | 35 | 35 | 36 | 34 |

## PENTAMETHYLENE DICYANIDE or PIMELONITRILE $CN.(CH_2)_5.CN$

**Constants:** SERWY (1933)

*Freezing point:* −31°4

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.96181 | |
| 15 | 0.95070 | |
| 30 | 0.93961 | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 9080 | |
| 30 | 5501 | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | Hγ |
|---|---|---|---|---|---|---|---|
| 15 | 1.44010 | 1.44044 | 1.44278 | 1.44721 | 1.44816 | 1.45167 | 1.45721 |
| $\frac{dn}{dt}$ | 0.00030 | 30 | 30 | 30 | 29 | 31 | 32 |

ETHYL *iso*-CYANIDE or ETHYL CARBYLAMINE $CH_3.CH_2.NC$: LOWRY and HUDSON (1932) give a series of the refractive index.

# 10. NITROGEN DERIVATIVES of the CYCLIC SERIES

## A. AROMATIC AMINES

The purity of these amines may be ascertained by transformation into an acetyl derivative of which the melting point is determined.

The velocity of crystallization is a very sensitive criterion of purity. This applies to all aromatic amines; the velocity is much reduced for impure colored samples.

### ANILINE $C_6H_5NH_2$

**Constants:** B.E. (1935). — **Polyphasic equilibria**

*Velocity of crystallization:* −9°2 11.5 cm/min. MICHEL (1938)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 102.80 | 50.90 | 119.10 | 96.31 | 131.60 | 152.95 | GARRICK (1927) |
| 108.40 | 63.44 | 122.52 | 110.57 | 134.10 | 166.70 | „ |
| 108.80 | 64.41 | 123.82 | 115.59 | 135.10 | 172.69 | „ |
| 114.50 | 81.05 | 124.80 | 118.52 | 141.50 | 214.30 | „ |
| 115.65 | 84.94 | 126.00 | 124.47 | 147.90 | 264.52 | „ |
| 77.4 | 16.2 | 144.45 | 237.8 | 171.8 | 544.1 | RAMSAY and YOUNG |
| 85.8 | 24.1 | 147.2 | 260.6 | 174.95 | 592.7 | „ (1885) |
| 93.0 | 33.6 | 147.55 | 263.6 | 176.1 | 612.1 | „ |
| 99.0 | 43.8 | 150.15 | 286.0 | 177.8 | 638.8 | „ |
| 105.1 | 56.5 | 152.5 | 307.0 | 178.1 | 646.2 | „ |
| 124.5 | 118.8 | 155.05 | 333.3 | 180.55 | 690.7 | „ |
| 128.45 | 137.1 | 157.2 | 355.5 | 181.15 | 701.5 | „ |
| 129.95 | 145.25 | 162.15 | 411.9 | 182.1 | 719.8 | „ |
| 132.15 | 156.2 | 165.4 | 452.9 | 184.3 | 762.2 | „ |
| 134.6 | 169.9 | 168.65 | 497.1 | 184.45 | 763.6 | „ |
| 141.9 | 219.4 | | | | | „ |

*Boiling point*

| | | |
|---|---|---|
| 184°35 | $\frac{dt}{dp}$ *(10 mm):* | 0°51 LECAT |
| 184°40 | „ | 0°51 B.E. (1935) |
| 184°40 | „ | 0°52 RAMSAY and YOUNG (1887) |
| 184°4 | „ | 0°53 GRIFFITHS (1891) |
| | „ | 0°49 HARLOW (1912) |

*Freezing point*

| | | | |
|---|---|---|---|
| −5·95 | Atkins and Wallace (1913) | −6·05 | Lang (1928) |
| −5°96 | Ampola and Rimatori (1897) | −6°1 | Linard (1925) |
| −5·98 | Applebey and Davies (1925) | −6·10 | B.E. (1935) and Deffet (1935) |

*Melting curve:* Deffet (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| −6.10 | 1 | 10.00 | 841 |
| 0.00 | 317 | 13.00 | 996 |
| 5.50 | 598 | | |

*Critical solution point in* $C_6H_{12}$: 30°95 Schlegel (1934)
31°0 Dessart (1926)
31°0 B.E. (1935)

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.03905 | B.E. (1935) | 0 | 1.0390 | Bramley (1916) |
| 15 | 1.02613 | „ | 9.9 | 1.0303 | „ |
| 30 | 1.01317 | „ | 20 | 1.0219 | „ |
| | | | 20.2 | 1.0214 | „ |
| 0 | 1.03893 | Dan Tyrer (1914) | 29.6 | 1.0134 | „ |
| 0 | 1.03894 | Wiebe (1894) | 30 | 1.0131 | „ |
| 20 | 1.0217 | Knops (1888) | 40 | 1.0045 | „ |
| 20 | 1.0217 | Biron, Nikitine and Jakobson (1913) | 60 | 0.9872 | „ |
| | | | 80 | 0.9700 | „ |
| 20 | 1.0218 | Tsakalotos (1909) | 125 | 0.9288 | „ |
| 20 | 1.0219 | Busse (1924) | | | |
| 20 | 1.0220 | Weegmann (1888) | 25 | 1.01739 | Gibson and Loeffler (1939) |
| 20 | 1.02173 | Dreisbach and Martin (1949) | 25 | 1.0174 | Few and Smith (1949) |
| | | | 25 | 1.01749 | Martin and Collie (1932) |
| 25 | 1.01750 | | 25 | 1.0176 | Angelescu and Eustatiu (1936) |
| 25 | 1.0173 | Walden and Andrieth (1933) | | | |
| 25 | 1.0173 | Smith, Foecking and Barber (1949) | 35 | 1.0088 | Biron, Nikitine and Jakobson (1913) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 5299 | B.E. (1935) | 30 | 3145 | Bramley (1916) |
| 30 | 3176 | „ | 40 | 2405 | „ |
| 25 | 3640 | Sachanow (1913) | 60 | 1540 | „ |
| | | | 80 | 1100 | „ |
| | | | 125 | 637 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 7.30 | 44.72 | Bodson (1937) | 47.5 | 40.40 | Bodson (1937) |
| 19.0 | 43.38 | „ | 82.0 | 36.60 | „ |
| 32.0 | 42.01 | „ | 25 | 42.79 | Angelescu and Eustatiu (1936) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 1.58079 | 1.58179 | 1.58872 | 1.58898 | 1.60333 | 1.60686 | 1.61854 | — | B.E. (1935) |
| $\frac{\Delta n}{\Delta t}$ | 0.00051 | 51 | — | 52 | 54 | 55 | 55 | — | „ |
| 20 | — | — | — | 1.58635 | 1.60060 | — | 1.61559 | — | Feussner (1927) |
| $\frac{\Delta n}{\Delta t}$ | — | — | — | 513 | 527 | — | 546 | — | „ |
| 20 | — | 1.57926 | 1.58632 | — | — | 1.60411 | — | 1.62036 | Weegmann (1888) |
| 20 | — | 1.57904 | — | — | — | 1.60380 | — | 1.62023 | Knops (1888) |
| 25 | — | 1.57662 | — | — | — | — | — | — | Martin and Collie (1932) |
| 25 | — | — | 1.5840 | — | — | — | — | — | Smith, Foecking and Barber (1949) |

## Heat constants

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | |
|---|---|---|---|---|---|---|
| 30 | 0.500 | 70 | 0.532 | 113.8 | 0.564 | Blacet, Leighton and Bartlett (1931) |
| 35 | 0.503 | 75 | 0.533 | 118.9 | 0.575 | |
| 40 | 0.507 | 80 | 0.535 | 124.0 | 0.581 | „ |
| 45 | 0.512 | 85 | 0.536 | 129.2 | 0.601 | „ |
| 50 | 0.515 | 90 | 0.538 | 134.4 | 0.627 | „ |
| 55 | 0.520 | 95 | 0.545 | 139.6 | 0.665 | „ |
| 60 | 0.526 | 104.8 | 0.552 | | | „ |
| 65 | 0.528 | 108.8 | 0.559 | | | |
| 20.08 | 0.4951 | 30.05 | 0.4981 | 40.07 | 0.5019 | Ferguson and Miller |
| 26.45 | 0.4969 | 35.63 | 0.5000 | 46.82 | 0.5054 | „ (1933) |
| 1.08 | 0.4778 | 15.00 | 0.4945 | 35.71 | 0.5006 | Lang (1928) |
| 2.21 | 0.4876 | 26.06 | 0.4971 | 43.09 | 0.5030 | |
| 4.18 | 0.4895 | 31.29 | 0.4983 | 49.42 | 0.5091 | |
| | | 35.00 | 0.5006 | 58.87 | 0.5131 | |

## METHYLANILINE $C_6H_5NH.CH_3$

**Constants:** B.E. (1935)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 66.7 | 5 | 92.6 | 20 | 107.6 | 40 | Kahlbaum (1897) |
| 79.2 | 10 | 97.2 | 25 | 112.5 | 50 | ,, |
| 86.9 | 15 | 101.1 | 30 | 122.5 | 75 | ,, |

*Boiling point:* 196°25 $\frac{dt}{dp}$ *(10 mm):* 0°53 B.E. (1935) and Lecat

*Density*

| t° | d | |
|---|---|---|
| 0 | 1.00216 | B.E. (1935) |
| 15 | 0.99018 | ,, |
| 30 | 0.97822 | ,, |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 2568 | B.E. (1935) | 25 | 2020 | Mussell, Thole and Dunstan (1912) |
| 30 | 1766 | ,, | 55 | 1084 | Thole (1913) |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 39.97 | Bodson (1937) | 60 | 36.19 | Bodson (1937) |
| 30 | 39.54 | ,, | 80 | 34.49 | ,, |

*Refractive index*

| t° | Li | He r. | Hα | D | He y. | He g. | Tl | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | — | 1.56590 | 1.56676 | 1.57367 | 1.57392 | 1.58810 | — | 1.59181 | 1.60365 | — | B.E. (1935) |
| $\frac{dn}{dt}$ | — | 0.00052 | 52 | — | 53 | 53 | — | 54 | 55 | — | ,, |
| 21.2 | 1.56227 | | 1.56348 | 1.57021 | — | — | 1.57806 | 1.58823 | — | 1.60322 | Becker (1895) |
| 25 | — | — | — | 1.5684 | — | — | — | — | — | — | Puschin and Matayeva (1932) |

## DIMETHYLANILINE $C_6H_5\,N(CH_3)_2$

**Constants:** B.E. (1935)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 61.6 | 5 | KAHLBAUM (1897) | 183.3 | 574 | KURBATOW (1903) |
| 73.1 | 10 | „ | 184.9 | 600 | „ |
| 81.2 | 15 | „ | 188.15 | 650 | „ |
| 87.5 | 20 | „ | 191.1 | 700 | „ |
| 92.30 | 25 | „ | 193.8 | 750 | „ |
| 96.3 | 30 | „ | 194.5 | 763 | „ |
| 102.8 | 40 | „ | | | |
| 108.2 | 50 | „ | | | |
| 118.3 | 75 | „ | | | |

*Boiling point*

| | | |
|---|---|---|
| 194°05 | $\frac{dt}{dp}$ *(10 mm)*: | 0°52 LECAT |
| 194°15 | „ | 0°53 B.E. (1935) |
| 194°3 | „ | 0°54 KURBATOW (1903) |

*Freezing point*

| | |
|---|---|
| 2°40 | DEFFET (1935) |
| 2°45 | B.E. (1935) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 2.40 | 1 | 20.00 | 783 | |
| 10.00 | 322 | 25.00 | 998 | |
| 15.00 | 570 | | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.97232 | B.E. (1935) | 21.3 | 0.9551 | FALK (1909) |
| 15 | 0.96012 | „ | 36.2 | 0.9429 | „ |
| 30 | 0.94804 | „ | 43.3 | 0.9371 | „ |
| 21.5 | 0.9549 | GUYE and MALLET (1902) | 53.4 | 0.9289 | „ |
| 25 | 0.95185 | MARTIN and COLLIE (1932) | 55 | 0.9274 | THOLE (1913) |
| 25 | 0.95196 | FEW and SMITH (1949) | | | |
| 25 | 0.95198 | LE FEVRE and LE FEVRE (1936) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1528 | B.E. (1935) |
| 30 | 1159 | „ |
| 30 | 1170 | Puschin and Pinter (1929) |
| 55 | 844 | Thole (1913) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 36.60 | Bodson (1937) |
| 40 | 34.43 | „ |
| 60 | 32.33 | „ |
| 80 | 30.20 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.55309 | 1.55404 | 1.56083 | 1.56109 | 1.57531 | 1.57866 | 1.59063 | — | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00049 | 48 | — | 50 | 51 | 50 | — | — | „ |
| 18.4 | — | 1.55250 | 1.55914 | — | — | 1.57710 | — | 1.59422 | Falk (1909 (→ 73 4) |
| 24.6 | — | 1.54959 | 1.55620 | — | — | 1.57396 | — | 1.59059 | „ |
| 27.1 | — | 1.54847 | 1.55502 | — | — | 1.57267 | — | 1.58954 | „ |
| 32.5 | — | 1.54570 | 1.55230 | — | — | 1.56989 | — | 1.58651 | „ |
| $\frac{dn}{dt}$ | — | 0.000495 | 499 | — | — | 519 | — | 539 | „ |
| 16.5 | — | — | 1.5599 | — | — | — | — | — | Puschin and Matavulj (1932) |
| 25 | — | 1.54923 | — | — | — | — | — | — | Martin and Collie (1932) |

## ETHYLANILINE $C_6H_5.NH.C_2H_5$

### Constants

*Saturated vapour pressure:* Kahlbaum and Tesse (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 49.0 | 1 | 85.6 | 11 | 98.7 | 21 | 107.5 | 31 | 114.3 | 41 |
| 57.8 | 2 | 87.2 | 12 | 99.7 | 22 | 108.3 | 32 | 114.9 | 42 |
| 63.9 | 3 | 88.8 | 13 | 100.7 | 23 | 109.0 | 33 | 115.5 | 43 |
| 68.5 | 4 | 90.3 | 14 | 101.6 | 24 | 109.7 | 34 | 116.0 | 44 |
| 72.0 | 5 | 91.7 | 15 | 102.5 | 25 | 110.4 | 35 | 116.5 | 45 |
| 74.8 | 6 | 93.0 | 16 | 103.4 | 26 | 111.1 | 36 | 117.1 | 46 |
| 77.4 | 7 | 94.2 | 17 | 104.3 | 27 | 111.8 | 37 | 117.6 | 47 |
| 79.8 | 8 | 95.4 | 18 | 105.1 | 28 | 112.4 | 38 | 118.2 | 48 |
| 81.0 | 9 | 96.5 | 19 | 105.9 | 29 | 113.0 | 39 | 118.7 | 49 |
| 83.8 | 10 | 97.6 | 20 | 106.7 | 30 | 113.6 | 40 | 119.1 | 50 |

*Boiling point:* 205°5 LECAT

*Freezing point:* −65°8 TIMMERMANS

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0.0 | 0.9796 | DUTOIT and FRIEDERICH (1900) (KAHLBAUM'S | 0 | 0.9793 | RADICE (1899) |
| | | | 20 | 0.9628 | COWLEY and PARTINGTON (1933) |
| 13.1 | 0.9686 | „ sample) | | | |
| 37.5 | 0.9484 | „ | 20 | 0.96315 | KAHLBAUM (1898) |
| 54.1 | 0.9343 | „ | | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 20 | 1.54994 | 1.55593 | 1.57239 | 1.58761 | KAHLBAUM (1898) |
| 20 | — | 1.5559 | — | — | COWLEY and PARTINGTON (1933) |

## DIETHYLANILINE $C_6H_5.N(C_2H_5)_2$

### Constants

*Saturated vapour pressure:* KAHLBAUM and TESSE (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 63.2 | 2 | 99.2 | 14 | 113.1 | 26 | 121.3 | 37 | 126.0 | 45 |
| 70.0 | 3 | 100.7 | 15 | 116.4 | 30 | 121.9 | 38 | 126.5 | 46 |
| 87.6 | 8 | 102.1 | 16 | 117.2 | 31 | 122.5 | 39 | 127.0 | 47 |
| 89.8 | 9 | 103.5 | 17 | 117.9 | 32 | 123.1 | 40 | 127.5 | 48 |
| 91.9 | 10 | 109.3 | 22 | 118.6 | 33 | 123.7 | 41 | 128.1 | 49 |
| 93.9 | 11 | 110.3 | 23 | 119.3 | 34 | 124.3 | 42 | 128.6 | 50 |
| 95.8 | 12 | 111.3 | 24 | 120.0 | 35 | 124.8 | 43 | | |
| 97.5 | 13 | 112.2 | 25 | 120.6 | 36 | 125.4 | 44 | | |

| *Boiling point* | | *Freezing point* | | |
|---|---|---|---|---|
| 216°7 | BRÜHL (1895) | *Stable* form | −21°3 | TIMMERMANS |
| 217°05 | LECAT | *Unstable* form | −34°4 | „ |
| 217°5 | RICHARDS and MATTHEWS (1908) | | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0.0 | 0.9508 | Dutoit and Friederich | 20 | 0.93507 | Kahlbaum and Arndt (1898) |
| 10.8 | 0.9422 | „ (1900) | 20 | 0.9348 | Brühl (1895) |
| 36.1 | 0.9221 | (Kahlbaum's sample) | 22.3 | 0.9325 | „ |
| 54.4 | 0.9070 | „ | 20 | 0.93484 | Kremann, Meingast and Gugl (1914) |
| 0 | 0.9508 | Radice (1899) | | | |
| 0.0 | 0.9504 | Drucker and Kassel | 70 | 0.89469 | „ |
| 76.5 | 0.8901 | „ (1911) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 0 | 3838 | Drucker and Kassel (1911) |
| 76.5 | 783.0 | „ |
| 11 | 3251 | Kremann, Meingast and Gugl (1914) |

*Refractive index*

| t° | Li | Hα | D | Tl | Hβ | Hγ | |
|---|---|---|---|---|---|---|---|
| 20 | — | 1.53612 | 1.54206 | — | 1.55815 | 1.57294 | Kahlbaum and Arndt (1898) |
| 22.3 | 1.53408 | 1.53509 | 1.54105 | 1.54796 | — | 1.57077 | Brühl (1895) |

## *o*-TOLUIDINE $o\text{-}C_6H_4\,CH_3.NH_2$

**Constants:** B.E. (1935)

*Saturated vapour pressure:* I Kahlbaum (1898) and II Dreisbach and Shrader (1949)

| | t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 46.2 | 1 | 86.3 | 13 | 96.9 | 22 | 105.0 | 32 | 111.1 | 42 |
| | 61.4 | 3 | 87.7 | 14 | 98.8 | 24 | 106.3 | 34 | 112.2 | 44 |
| | 65.7 | 4 | 89.0 | 15 | 99.6 | 25 | 107.0 | 35 | 112.7 | 45 |
| | 69.3 | 5 | 90.3 | 16 | 100.5 | 26 | 107.6 | 36 | 113.2 | 46 |
| | 74.9 | 7 | 91.5 | 17 | 101.3 | 27 | 108.9 | 38 | 113.7 | 47 |
| | 79.4 | 9 | 92.7 | 18 | 102.1 | 28 | 109.5 | 39 | 114.2 | 48 |
| | 81.4 | 10 | 93.8 | 19 | 102.8 | 29 | 110.0 | 40 | 114.6 | 49 |
| | 83.1 | 11 | 94.9 | 20 | 104.3 | 31 | 110.6 | 41 | 115.1 | 50 |
| | 84.8 | 12 | 95.9 | 21 | | | | | | |
| II | 118.46 | 57.04 | 122.22 | 66.39 | 139.00 | 123.76 | 168.06 | 315.52 | 184.80 | 507.50 |

*Boiling point*

| | | |
|---|---|---|
| 200°30 | $\frac{dt}{dp}$ *(10 mm):* | 0°5203 Dreisbach and Martin (1949) |
| 200°35 | „ | 0°54 Lecat |
| 200°40 | „ | 0°54 B.E. (1935) |

*Freezing point*

| | | | | |
|---|---|---|---|---|
| *Stable* form | −16°4 | B.E. (1935) | −16°10 | DEFFET (1935) |
| *Metastable* „ | −24°4 | „ | −24°5 | „ |
| | −24°3 | BASKOW (1913) | | |

*Melting curve:* DEFFET (1935)

| *Stable form* | | *Metastable form* | |
|---|---|---|---|
| t° | p kg/cm² | t° | p kg/cm² |
| −16.10 | 1 | −24.5 | 1 |
| −11.0 | 285 | −15.0 | 500 |
| − 5.0 | 610 | −10.0 | 882 |
| + 0.10 | 876 | | |

*Critical solution point in n-$C_6H_{14}$:* 20°5 B.E. (1935)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.01531 | B.E. (1935) | 20 | 0.99885 | BIRON and MORGOULEWA (1914) |
| 15 | 1.00279 | „ | | | |
| 30 | 0.99037 | „ | 12 | 1.0053 | KREMANN, MEINGAST and |
| 0 | 1.0153 | BINGHAM, VAN KLOOSTER | 18 | 1.0003 | „ GUGL (1914) |
| 20 | 0.9988 | and KLEINSPEHN (1920) | 21 | 0.9979 | „ |
| 40 | 0.9823 | „ | 26 | 0.9937 | „ |
| 60 | 0.9656 | „ | 42.6 | 0.9801 | „ |
| 80 | 0.9489 | „ | 54 | 0.9706 | „ |
| 100 | 0.9313 | „ | 64 | 0.9625 | „ |
| | | | 65.5 | 0.9611 | „ |
| 0 | 1.01524 | WIEBE (1894) | 70 | 0.95749 | „ |
| 20 | 0.9986 | BIRON and MORGOULEWA (1915) | 77.4 | 0.9515 | „ |
| 20 | 0.9986 | RICHARDS and MATHEWS (1908) | 35 | 0.9865 | BIRON, NIKITINE and JAKOBSON (1913) |
| 20 | 0.9986 | BRÜHL (1895) | 54.5 | 0.9700 | HERZEN (1902) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 5195 | B.E. (1935) |
| 30 | 3183 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 40.59 | LEK (1930) | 20 | 40.10 | BODSON (1937) |
| 20 | 40.03 | „ | 30 | 38.99 | „ |
| 30 | 38.93 | „ | 50 | 36.83 | „ |
| | | | 80 | 33.52 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He γ. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.56762 | 1.56853 | 1.57512 | 1.58823 | 1.59146 | 1.60128 | B.E. (1935) |
| $\frac{dn}{d}$ | 0.00046 | 47 | 48 | 48 | 49 | 49 | „ |

## *m*-TOLUIDINE $m\text{-}C_6H_4\,CH_3.NH_2$

**Constants:** B.E. (1935)

*Saturated vapour pressure:* KAHLBAUM and TOENNIES (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 58.9 | 2 | 88.5 | 12 | 99.4 | 21 | 107.9 | 31 | 114.7 | 42 |
| 64.8 | 3 | 90.0 | 13 | 100.4 | 22 | 108.6 | 32 | 115.3 | 43 |
| 69.3 | 4 | 91.4 | 14 | 101.3 | 23 | 109.3 | 33 | 115.8 | 44 |
| 72.8 | 5 | 92.7 | 15 | 102.2 | 24 | 110.6 | 35 | 116.3 | 45 |
| 76.0 | 6 | 94.0 | 16 | 103.1 | 25 | 111.2 | 36 | 116.8 | 46 |
| 78.8 | 7 | 95.2 | 17 | 103.9 | 26 | 112.5 | 38 | 117.3 | 47 |
| 83.3 | 9 | 96.3 | 18 | 104.8 | 27 | 113.1 | 39 | 117.8 | 48 |
| 85.3 | 10 | 97.4 | 19 | 105.6 | 28 | 113.6 | 40 | 118.2 | 49 |
| 87.0 | 11 | 98.5 | 20 | 107.1 | 30 | 114.2 | 41 | 118.7 | 50 |

*Boiling point*

| | | |
|---|---|---|
| 203°1 | $\frac{dt}{dp}$ *(10 mm):* 0°55 | LECAT |
| 203°40 | „ 0°55 | B.E. (1935) |

*Freezing point*

| | |
|---|---|
| −31°0 | O'CONNOR (1924) |
| −31°25 | B.E. (1935) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.00515 | B.E. (1935) | 20 | 0.9888 | BUSSE (1924) |
| 15 | 0.99302 | „ | 20 | 0.98912 | KAHLBAUM (1898) |
| 30 | 0.98096 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 4418 | B.E. (1935) | 55 | 1513 | THOLE (1913) |
| 30 | 2741 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 20 | 38.02 | BODSON (1937) | 60 | 34.54 | BODSON (1937) |
| 30 | 37.16 | „ | 70 | 33.67 | „ |
| 40 | 36.28 | „ | 80 | 32.75 | „ |
| 50 | 35.42 | „ | | | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.56293 | 1.56384 | 1.57047 | 1.58346 | 1.58672 | 1.59729 |
| $\frac{dn}{dt}$ | 0.00045 | 47 | 48 | 48 | 49 | 49 |

## *p*-TOLUIDINE $p\text{-}C_6H_4\,CH_3.NH_2$

**Constants:** B.E. (1937)

*Saturated vapour pressure:* KAHLBAUM and TOENNIES (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 46.9 | 1 | 85.5 | 12 | 97.6 | 22 | 105.0 | 31 | 110.7 | 40 |
| 55.9 | 2 | 87.0 | 13 | 98.5 | 23 | 105.7 | 32 | 111.3 | 41 |
| 62.0 | 3 | 88.4 | 14 | 99.4 | 24 | 106.4 | 33 | 111.8 | 42 |
| 66.4 | 4 | 89.7 | 15 | 100.2 | 25 | 107.1 | 34 | 113.4 | 45 |
| 70.1 | 5 | 91.1 | 16 | 101.1 | 26 | 107.7 | 35 | 113.9 | 46 |
| 73.0 | 6 | 92.3 | 17 | 102.0 | 27 | 108.3 | 36 | 114.4 | 47 |
| 75.7 | 7 | 93.4 | 18 | 102.7 | 28 | 109.0 | 37 | 114.9 | 48 |
| 80.3 | 9 | 94.5 | 19 | 103.4 | 29 | 109.6 | 38 | 115.3 | 49 |
| 82.2 | 10 | 95.6 | 20 | 104.3 | 30 | 110.2 | 39 | 115.8 | 50 |
| 83.9 | 11 | 96.6 | 21 | | | | | | |

*Boiling point*

200°55 | $\frac{dt}{dp}$ *(10 mm):* 0°54 B.E. (1937) and LECAT

*Freezing point*

| | | | |
|---|---|---|---|
| 43°7 | TURNER and POLLARD (1914) | 43°73 | HULETT (1899) |
| 43°7 | CAUWOOD and TURNER (1915) | | N.B. (in the work, sometimes 43°73 and sometimes 43°90) |
| | | 43°75 | B.E. (1937) and DEFFET (1935) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 43.75 | 1 | 60.00 | 683 |
| 50.00 | 269 | 65.00 | 890 |
| 55.00 | 476 | 67.00 | 973 |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 45 | 0.96589 | B.E. (1937) | 44 | 0.9663 | TURNER and POLLARD (1914) |
| 50 | 0.96155 | „ | | | |
| 55 | 0.95766 | „ | 50 | 0.9612 | MORGAN and STONE (1913) |
| 60 | 0.95384 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 45 | 1945 | B.E. (1937) |
| 60 | 1425 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 45 | 36.06 | BODSON (1937) and B.E. (1937) |
| 60 | 34.10 | „ „ |
| 80 | 31.54 | „ „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 45 | 1.54653 | 1.54741 | 1.55370 | 1.56627 | 1.56974 | 1.57985 |
| $\frac{dn}{d}$ | 0.00052 | 54 | 54 | 54 | — | — |

## DIMETHYL-*o*-TOLUIDINE $o\text{-}C_6H_4\ CH_3.N(CH_3)_2$

### Constants

*Saturated vapour pressure:* KAHLBAUM (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 54.1 | 5 | 73.9 | 15 | 84.4 | 25 | 91.4 | 34 | 96.8 | 43 |
| 57.2 | 6 | 75.2 | 16 | 85.3 | 26 | 91.9 | 36 | 97.3 | 44 |
| 59.9 | 7 | 76.4 | 17 | 86.1 | 27 | 92.6 | 35 | 97.9 | 45 |
| 62.2 | 8 | 77.6 | 18 | 86.9 | 28 | 93.2 | 37 | 99.9 | 49 |
| 64.3 | 9 | 78.7 | 19 | 87.7 | 29 | 93.8 | 38 | 100.4 | 50 |
| 66.2 | 10 | 79.7 | 20 | 88.5 | 30 | 94.5 | 39 | 102.7 | 55 |
| 67.9 | 11 | 80.7 | 21 | 89.2 | 31 | 95.1 | 40 | 104.8 | 60 |
| 69.6 | 12 | 81.7 | 22 | 89.9 | 32 | 95.6 | 41 | 110.4 | 75 |
| 71.0 | 13 | 82.6 | 23 | 90.6 | 33 | 96.2 | 42 | 118.1 | 100 |
| 72.5 | 14 | 83.6 | 24 | | | | | | |

*Freezing point:* −61°3 TIMMERMANS

*Density*

| t° | d | |
|---|---|---|
| 20 | 0.92859 | KAHLBAUM (1898) |
| 20 | 0.9286 | BIRON and MORGOULEWA (1915) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 55° | 881 | THOLE (1913) |

*Refractive index*

| t° | Hα | D | Hβ | |
|---|---|---|---|---|
| 20 | 1.52123 | 1.52643 | 1.55201 | KAHLBAUM (1898) |

DIMETHYL-*p*-TOLUIDINE: $p\text{-}C_6H_4.CH_3.N(CH_3)_2$: *Saturated vapour pressure, density* and *refractive index:* KAHLBAUM (1898)

*m*-XYLIDINE: $m\text{-}C_6H_3.(CH_3)_2.NH_2$: *Boiling point, density* and *refractive index:* BRÜHL (1895).

## DIPHENYLAMINE $(C_6H_5)_2\ NH$

### Constants

*Saturated vapour pressure:* HEIN (1914)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 278 | 450.0 | 280 | 470.0 | 282 | 491.0 | 284 | 515.0 |
| 279 | 460.0 | 281 | 480.0 | 283 | 503.0 | 285 | 527.0 |

*Freezing point*

| | | | |
|---|---|---|---|
| 52°7 | Böeseken (1912) | 53°0 | Hrynakowski and Smoczkiewiczowna (1937) |
| 52°8 | Lee and Warner (1933) | 53°2 | Puschin and Grebenschtchikow (1912) |
| 52°85 | Narbutt (1905) | 53°5 | Baskow (1920) |
| 52°93 | Campetti (1912–13) | | |

*Melting curve:* Puschin and Grebenschtchikow (1912–13)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| 53.2 | 1 | 85.35 | 1250 |
| 68.0 | 550 | 92.5 | 1550 |
| 72.9 | 750 | 96.65 | 1750 |
| 80.7 | 1050 | 103.5 | 2050 |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 60 | 1.0547 | Turner and Merry (1910) | 53 | 1.0573 | Turner and Pollard (1914) |
| 75 | 1.0435 | „ | | | |
| 90 | 1.0326 | „ | 77 | 1.0418 | Dutoit and Friederich (1900) |
| 105 | 1.0117 | „ | | | |
| | | | 61 | 1.0543 | Bramley (1916) |
| | | | 81 | 1.0377 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 61 | 4170 | Bramley (1916) |
| 81 | 2525 | „ |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 60 | 39.23 | Turner and Merry (1910) | 90 | 36.23 | Turner and Merry (1910) |
| 75 | 37.77 | „ | 105 | 34.66 | „ |

TRIPHENYLAMINE: $(C_6H_5)_3N$: *Saturated vapour pressure, melting point, density* and *surface tension:* Foward, Bowden and Jones (1949)

| | DIBENZYLAMINE $(C_6H_5CH_2)_2$ NH | | TRIBENZYLAMINE $(C_6H_5CH_2)_3$ N | |
|---|---|---|---|---|
| **Constants:** TURNER and MERRY (1910) | | | | |
| *Density* | 20° | 1.0276 | 95° | 0.9912 |
| | 30° | 1.0199 | 105° | 0.9856 |
| | 45° | 1.0083 | 120° | 0.9741 |
| | 60° | 0.9963 | 135° | 0.9682 |
| | 75° | 0.9844 | | |
| *Surface tension* | 20° | 40.68 | 95° | 33.34 |
| | 30° | 39.61 | 105° | 32.43 |
| | 45° | 38.01 | 120° | 30.97 |
| | 60° | 36.40 | 135° | 29.54 |
| | 75° | 34.79 | | |

## PHENYLHYDRAZINE $C_6H_5NH.NH_2$

**Constants**

*Melting point*

| | | | |
|---|---|---|---|
| 19° | PUSCHIN and RIKOWSKI (1932) | 19°6 | BLANKSMA (1910) |
| 19°35 | ODDO (1915) | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 1.0981 | BRÜHL (1895) | 20 | 1.0978 | TURNER and MERRY (1910) |
| 20.3 | 1.0978 | „ | 30 | 1.0899 | „ |
| 30 | 1.0902 | PUSCHIN and PINTER (1929) | 45 | 1.0777 | „ |
| | | | 60 | 1.0653 | „ |

*Viscosity* *Surface tension*

| t° | $\eta \cdot 10^5$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 30 | 10090 | PUSCHIN and PINTER (1929) | 20 | 45.55 | TURNER and MERRY (1910) |
| | | | 30 | 44.31 | „ |
| 50 | 4580 | THOLE, MUSSELL and DUNSTAN (1913) | 45 | 42.27 | „ |
| | | | 60 | 40.40 | „ |

*Refractive index*

| t° | He r. | Hα | D | Tl | Hβ | Hγ | |
|---|---|---|---|---|---|---|---|
| 10.3 | 1.59993 | 1.60118 | 1.60813 | 1.61630 | 1.62673 | 1.64368 | BRÜHL (1895) |
| 16.5 | — | — | 1.6094 | — | — | — | PUSCHIN and MATAVULJ (1932) |

METHYLPHENYLHYDRAZINE: $C_6H_5NH.NHCH_3$: *Boiling point, density* and *refractive index:* BRÜHL (1895).

## B. AROMATIC NITRILES

### BENZONITRILE $C_6H_5CN$

**Constants:** B.E. (1935)

*Saturated vapour pressure:* KAHLBAUM and WIRKNER (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 62.8 | 7.0 | 77.9 | 15.6 | 90.6 | 28.0 | 99.2 | 41.2 |
| 64.6 | 7.7 | 79.0 | 16.4 | 91.0 | 28.6 | 99.5 | 41.6 |
| 65.0 | 8.2 | 79.2 | 16.7 | 91.7 | 29.6 | 99.9 | 42.3 |
| 67.1 | 9.0 | 80.4 | 17.6 | 92.0 | 29.9 | 100.5 | 43.5 |
| 67.2 | 9.1 | 80.6 | 17.8 | 92.8 | 31.0 | 100.7 | 43.8 |
| 69.4 | 10.1 | 82.1 | 19.2 | 93.2 | 31.5 | 101.1 | 44.6 |
| 69.7 | 10.2 | 82.3 | 19.4 | 93.6 | 32.1 | 101.8 | 45.8 |
| 71.6 | 11.3 | 83.6 | 20.5 | 94.0 | 32.8 | 102.1 | 46.5 |
| 72.8 | 12.1 | 84.8 | 21.9 | 94.3 | 33.3 | 102.4 | 47.0 |
| 73.6 | 12.3 | 85.4 | 22.1 | 95.0 | 34.2 | 103.0 | 48.2 |
| 74.4 | 12.9 | 85.8 | 22.6 | 95.4 | 35.1 | 103.2 | 49.4 |
| 75.3 | 13.5 | 86.0 | 22.9 | 95.9 | 35.9 | 103.5 | 50.0 |
| 75.4 | 13.6 | 87.1 | 24.0 | 96.0 | 36.1 | 104.1 | 50.6 |
| 75.5 | 13.8 | 88.1 | 25.0 | 96.8 | 37.0 | 104.7 | 51.7 |
| 76.1 | 14.2 | 88.6 | 25.9 | 97.3 | 38.0 | 104.9 | 52.0 |
| 76.6 | 14.6 | 89.2 | 26.5 | 97.8 | 38.8 | 105.2 | 52.9 |
| 76.9 | 14.7 | 90.2 | 27.4 | 98.5 | 40.0 | 105.8 | 54.0 |
| 77.6 | 15.4 | | | | | | |

*Boiling point*

| | |
|---|---|
| 190°89 | LOUGUININE (1900) |
| 191°10 | $\frac{dt}{dp}$ *(10 mm):* 0°47 B.E. (1935) and LECAT |

*Freezing point:* −13°2 DEFFET (1935)
−13°8 B.E. (1935)

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|
| −13.2 | 1 | 0.00 | 660 |
| −10.0 | 160 | 5.00 | 910 |
| − 5.0 | 408 | 6.00 | 961 |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.02275 | B.E. (1935) | 8 | 1.0157 | Guye and Baud (1901) |
| 15 | 1.00948 | „ | 54.9 | 0.9726 | „ |
| 30 | 0.99628 | „ | 99.1 | 0.9388 | „ |
| | | | 152.4 | 0.8848 | „ |
| 0 | 1.0227 | Walden (1908–09) | 25 | 1.0006 | Sugden (1933) |
| 0 | 1.02279 | Timmermans (1910) | 25 | 1.00088 | Le Fevre and Le Fevre (1936) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 1447 | B.E. (1935) |
| 30 | 1111 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.52444 | 1.52526 | 1.53082 | 1.54180 | 1.54461 | 1.55326 |
| $\frac{dn}{dt}$ | 0.00048 | 48 | 48 | 49 | 49 | 49 |

DIAZOBENZENEIMIDE or PHENYLAZOIMIDE: $C_6H_5-N=N\equiv N$: *Saturated vapour pressure, density* and *viscosity:* Carothers (1923)

## C. NITROGEN DERIVATIVES of the POLYMETHYLENES

### *Cyclo*-PENTYLAMINE $C_5H_9NH_2$

**Constants**: La Bruyere (unp.)

*Freezing point:* −85°7

*Density*

| t° | d | |
|---|---|---|
| 0 | 0.87843 | |
| 15 | 0.86449 | |
| 30 | 0.85047 | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 12388 | |
| 30 | 9567 | |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 31.38 |
| 20 | 30.75 |
| 30 | 29.50 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.44942 | 1.44978 | 1.45238 | 1.45738 | 1.45852 | 1.46221 |
| $\frac{dn}{dt}$ | 0.00047 | 47 | 48 | 52 | 52 | 51 |

*Cyclo*-HEXYLAMINE: $C_6H_{11}NH_2$ and DI- *cyclo*-HEXYLAMINE: $(C_6H_{11})_2NH$: *Boiling* and *freezing points*, *density* and *refractive index*: CARSWELL and MORRILL (1937) and VAN DE VLOED (1938-1939)

*Cyclo*-PENTYLCYANIDE: $C_5H_9CN$: *Boiling point*, *density* and *refractive index*: ROGERS and ROBERTS (1946)

## *Cyclo*-HEXYLCYANIDE $C_6H_{11}CN$

**Constants:** LA BRUYERE (unp.)

*Freezing point:* 12°04

| *Density* | | | *Viscosity* | | | *Surface tension* | |
|---|---|---|---|---|---|---|---|
| t° | d | | t° | $\eta \cdot 10^5$ | | t° | $\gamma$ |
| 15 | 0.91736 | | 15 | 3295 | | 15 | 34.91 |
| 30 | 0.90498 | | 30 | 2331 | | 20 | 34.37 |
| | | | | | | 30 | 33.29 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | He v. | |
|---|---|---|---|---|---|---|
| 15 | 1.45086 | 1.45111 | 1.45359 | 1.45804 | 1.46255 | |
| $\frac{dn}{dt}$ | 0.00042 | 42 | 42 | 42 | 43 | |

# D. HETEROCYCLIC DERIVATIVES

## PYRIDINE $C_5H_5N$

**Constants:** B.E. (1937)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 49.09 | 66.6 | 84.29 | 280.0 | 103.38 | 524.0 | HIEBER and WOERNER |
| 54.33 | 85.2 | 85.53 | 300.4 | 103.97 | 533.8 | ,, (1934) |
| 60.03 | 110.9 | 87.57 | 313.4 | 106.66 | 579.5 | ,, |
| 61.57 | 118.4 | 90.16 | 342.4 | 107.84 | 605.0 | ,, |
| 63.75 | 129.6 | 90.54 | 358.3 | 111.66 | 678.6 | ,, |
| 65.83 | 139.6 | 93.42 | 380.0 | 112.51 | 693.8 | ,, |
| 67.41 | 149.8 | 94.62 | 395.3 | 113.08 | 705.2 | ,, |
| 74.09 | 192.6 | 95.83 | 412.8 | 113.48 | 715.6 | ,, |
| 74.62 | 199.6 | 97.07 | 426.4 | 114.97 | 742.8 | ,, |
| 78.75 | 229.8 | 98.31 | 446.5 | 115.56 | 759.6 | ,, |
| 80.15 | 244.2 | 100.32 | 476.2 | | | ,, |
| 42.9 | 50 | 55.6 | 90 | 86.1 | 300 | RILEY and BAILEY |
| 46.7 | 60 | 58.0 | 100 | 94.6 | 400 | ,, (1938) |
| 49.9 | 70 | 75.1 | 200 | 115.4 | 760 | ,, |
| 52.8 | 80 | | | | | ,, |

*Boiling point*

| | | | |
|---|---|---|---|
| 115°26 | HOFFMAN and VAN DER WERF (1946) | 115°50 | GRIMM and PATRICK (1923) |
| 115°37 | WAGNER and ZERNER (1910) | 115°50 | B.E. (1937) |
| 115°38 | UDOVENKO and AYRAPETOVA (1947) | 115°50 | TIMMERMANS (1910) |
| 115°4 | RILEY and BAILEY (1930) | 115°5 | ROSCHDESTWENSKY, PUKIREW and MASLOWA (1935) |
| 115°4 | LECAT | 115°58 | HIEBER and WOERNER (1934) |

$\frac{dt}{dp}$ *(10 mm):* 0°43 B.E. (1937) and LECAT

*Freezing point*

| | | | |
|---|---|---|---|
| −41°5 | HOFFMAN and VAN DER WERF (1946) | −41°7 | HAZLET and MORROW (1942) |
| −41°5 | B.E. (1937) | −42° | ZAWIDZKI (1906) |
| | | −42° | WAGNER and ZERNER (1910) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| −45.0 | 1.04882 | TIMMERMANS (1920) | 0 | 1.00296 | B.E. (1937) |
| −37.2 | 1.04059 | „ | 15 | 0.98783 | „ |
| −35.3 | 1.03894 | „ | 30 | 0.97281 | „ |
| −30.6 | 1.03385 | „ | 0 | 1.00296 | EWERT (1936) |
| −22.95 | 1.02606 | „ | 25 | 0.9782 | ROSCHDESTWENSKY, PUKIREW and MASLOWA (1935) |
| −13.1 | 1.01621 | „ | | | |
| − 6.2 | 1.00926 | „ | | | |
| 0 | 1.00303 | „ | | | |
| 15 | 0.98800 | „ | | | |
| 20 | 0.98300 | „ | | | |
| 25 | 0.97806 | „ | | | |
| 0 | 1.0031 | MÜLLER and BRENNEIS | 50 | 0.9526 | MÜLLER and BRENNEIS |
| 5 | 0.9982 | „ (1932) | 55 | 0.9474 | „ (1932) |
| 10 | 0.9935 | „ | 60 | 0.9424 | „ |
| 15 | 0.9877 | „ | 65 | 0.9366 | „ |
| 20 | 0.9826 | „ | 70 | 0.9318 | „ |
| 25 | 0.9778 | „ | 75 | 0.9267 | „ |
| 30 | 0.9729 | „ | 80 | 0.9211 | „ |
| 35 | 0.9677 | „ | 85 | 0.9164 | „ |
| 40 | 0.9629 | „ | 90 | 0.9111 | „ |
| 45 | 0.9575 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 1038 | B.E. (1937) | 30 | 829 | Dutoit and Duperthuis |
| 30 | 829 | „ | 40 | 724 | „ (1908) |
| | | | 50 | 639 | „ |
| 0 | 1360 | Dutoit and Duperthuis | 60 | 569 | „ |
| 10 | 1130 | „ (1908) | 70 | 508 | „ |
| 20 | 958 | „ | 80 | 462 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 37.86 | B.E. (1937) |
| 20 | 37.25 | „ |
| 30 | 35.70 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.50718 | 1.50778 | 1.51246 | 1.51271 | 1.52221 | 1.52459 | 1.53205 | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00051 | 51 | — | 52 | 54 | 54 | 54 | „ |
| 15 | 1.50718 | 1.50778 | — | 1.51273 | 1.52221 | 1.52430 | 1.53205 | Ewert (1936) |
| $\frac{dn}{dt}$ | 0.00051 | 51 | — | 52 | 54 | 54 | 54 | „ |
| 18.7 | — | — | 1.5106 | — | — | — | — | Grimm (1929) |
| 20 | — | — | 1.5100 | — | — | — | — | „ |
| 20 | — | — | 1.5102 | — | — | — | — | Roschdestwensky (1935), etc. |

*Specific heat:* 17° 0.409 Swietoslawski, Rybicka and Solodozowska (1931)

## α-PICOLINE or 2-METHYLPYRIDINE $\alpha\text{-}CH_3.C_5H_4N$

**Constants:** Freiser and Glowacki (1948)

*Saturated vapour pressure:* Riley and Bailey (1930)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|---|---|
| 128.8 | 760 | 98.6 | 300 | 70.6 | 100 | 65.1 | 80 | 56.8 | 60 |
| 107.0 | 400 | 88.8 | 200 | 68.0 | 90 | 61.8 | 70 | 53.3 | 50 |

*Boiling point*

| | | | |
|---|---|---|---|
| 128°8 | Riley and Bailey (1930) | 129°44 | $\frac{dt}{dp}$ *(10 mm)*: 0°46 Freiser and Glowacki(1948) |
| 128°8 | Constam and White (1903) | | |
| 129°0 | Hoffman and Van der Werf (1946) | | |

*Freezing point*

| | | | |
|---|---|---|---|
| −64°2 | Hoffman and Van der Werf (1946) | −66°55 | Freiser and Glowacki (1948) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | $0.94432_0$ | Freiser and Glowacki | 60 | $0.90665_8$ | Freiser and Glowacki |
| 30 | $0.93491_3$ | „ (1948) | 70 | $0.89706_6$ | „ (1948) |
| 40 | $0.92556_5$ | „ | 80 | $0.88722_2$ | „ |
| 50 | $0.91607_2$ | „ | 15 | 0.94972 | Constam and White (1903) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0 | 1097.0 | Freiser and Glowacki | 50 | 562.1 | Freiser and Glowacki |
| 10 | 935.1 | „ (1948) | 60 | 505.4 | „ (1948) |
| 20 | 810.2 | „ | 70 | 458.5 | „ |
| 30 | 709.6 | „ | 80 | 416.5 | „ |
| 40 | 629.6 | „ | | | |

*Refractive index*: Freiser and Glowacki (1948)

| t° | D | λ:546.1 | λ:435.8 | t° | D | λ:546.1 | λ:435.8 |
|---|---|---|---|---|---|---|---|
| 20 | 1.50105 | 1.50493 | 1.52170 | 30 | 1.49592 | 1.49982 | 1.51657 |

## *Iso*-QUINOLINE $C_9H_7N$

**Constants**: Freiser and Glowacki (1949)

*Boiling point*

243°25 $\frac{dt}{dp}$ *(10 mm)*: 0°59

*Freezing point*

26°48

*Density*

| t° | d | t° | d |
|---|---|---|---|
| 30 | 1.09101 | 100 | 1.03540 |
| 40 | 1.08309 | 125 | 1.01547 |
| 50 | 1.07519 | 150 | 0.99498 |
| 60 | 1.06731 | 175 | 0.97421 |
| 70 | 1.05945 | 200 | 0.95300 |
| 80 | 1.05143 | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|
| 30 | 3252.8 | 100 | 1023.0 |
| 40 | 2603.4 | 125 | 778.7 |
| 50 | 2132.3 | 150 | 621.7 |
| 60 | 1787.2 | 175 | 506.7 |
| 70 | 1526.9 | 200 | 422.3 |
| 80 | 1322.3 | | |

*Refractive index:* $n_D^{30°}$ : 1.62078

## QUINOLINE $C_9H_7N$

Prepared by synthesis using the method described by SKRAUP modified by DARZENS, DELABY and HIRON (1930); a commercial sample could not be purified sufficiently by fractional distillation.

**Constants**: B.E. (1937). — **Polyphasic equilibria**

*Saturated vapour pressure:* YOUNG (1889)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 75.3 | 2.55 | 126.05 | 26.75 | 166.85 | 115.65 | 205.05 | 346.8 |
| 78.3 | 2.75 | 128.06 | 29.25 | 168.05 | 119.7 | 207.2 | 368.1 |
| 81.1 | 3.25 | 132.25 | 33.6 | 170.95 | 131.2 | 210.1 | 395.8 |
| 83.05 | 3.75 | 134.95 | 37.4 | 171.05 | 132.6 | 210.2 | 400.7 |
| 86.55 | 4.55 | 138.1 | 42.1 | 174.5 | 147.55 | 213.2 | 428.45 |
| 90.05 | 5.50 | 141.05 | 47.3 | 177.35 | 159.8 | 214.8 | 448.2 |
| 93.65 | 6.15 | 144.15 | 54.15 | 179.6 | 171.85 | 216.05 | 460.0 |
| 96.55 | 7.15 | 146.65 | 58.0 | 183.15 | 190.45 | 218.9 | 493.0 |
| 99.45 | 8.1 | 149.5 | 64.1 | 187.15 | 213.8 | 219.35 | 500.0 |
| 102.1 | 9.3 | 152.15 | 70.0 | 190.1 | 232.55 | 221.9 | 528.8 |
| 104.3 | 10.65 | 154.95 | 77.2 | 192.65 | 249.5 | 224.25 | 560.3 |
| 107.4 | 11.8 | 157.85 | 84.8 | 194.65 | 263.9 | 228.0 | 610.9 |
| 110.05 | 13.6 | 159.15 | 90.2 | 195.55 | 269.2 | 228.45 | 621.1 |
| 113.05 | 15.6 | 160.15 | 93.25 | 198.1 | 288.35 | 231.1 | 656.0 |
| 115.9 | 17.55 | 163.05 | 101.3 | 200.15 | 304.9 | 232.8 | 683.3 |
| 118.1 | 19.1 | 164.6 | 107.2 | 201.2 | 313.95 | 233.95 | 701.7 |
| 120.75 | 21.3 | 165.4 | 109.4 | 204.1 | 339.35 | 236.65 | 745.3 |
| 123.45 | 23.85 | | | | | | |

*Boiling point*

| | |
|---|---|
| 237°10 | $\frac{dt}{dp}$ *(10 mm):* 0°57 B.E. (1937) |
| 237°3 | LECAT |
| 237°45 | YOUNG (1889) |

*Freezing point*

| | |
|---|---|
| −15°6 | B.E. (1937) |

## Constants of state

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.10957 | B.E. (1937) | 15 | 1.0978 | LUMSDEN (1907) |
| 15 | 1.09771 | „ | 40 | 1.0785 | „ |
| 30 | 1.08579 | „ | 80 | 1.0478 | „ |
| 10 | 1.1021 | GLADSTONE (1884) | 120 | 1.0150 | „ |
| 20 | 1.09391 | NASINI and CARRARA (1894) | 160 | 0.9826 | „ |
| | | | 200 | 0.9489 | „ |
| 25 | 1.0900 | WALDEN (1907) | 220 | 0.9319 | „ |
| 31.1 | 1.08407 | SCHWERS (1911) | | | |
| 53 | 1.06725 | „ | | | |
| 73.5 | 1.05090 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 4354 | B.E. (1937) |
| 30 | 2997 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 20 | 45.62 | B.E. (1937) and BODSON (1937) |
| 30 | 44.82 | „ |

*Refractive index*

| t° | Hα | D | He y. | He g. | Hβ | He v. | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.6212 | 1.62928 | 1.62954 | 1.64743 | 1.6522 | 1.66683 | — | B.E. (1937) |
| $\frac{dn}{dt}$ | — | — | 0.00048 | 49 | — | 50 | — | „ |
| 20 | 1.61927 | — | — | — | 1.65033 | — | 1.68067 | NASINI and CARRARA (1894) |
| 25 | — | 1.62475 | — | — | — | — | — | WALDEN (1907) |

## Heat constants

*Specific heat:* PARKS, TODD and MOORE (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −183.16 | 0.1068 | −123.16 | 0.1520 | −73.16 | 0.1975 | L. −13.16 | 0.3388 |
| −173.16 | 0.1136 | −113.16 | 0.1602 | −63.16 | 0.2076 | − 3.16 | 0.3466 |
| −163.16 | 0.1209 | −103.16 | 0.1688 | −53.16 | 0.2185 | + 6.84 | 0.3544 |
| −153.16 | 0.1283 | − 93.16 | 0.1779 | −43.16 | 0.234 | 16.84 | 0.3622 |
| −143.16 | 0.1360 | − 83.16 | 0.1876 | −33.16 | 0.257 | 26.84 | 0.3701 |
| −133.16 | 0.1440 | | | | | | |

| | | |
|---|---|---|
| *Heat of melting* | 19.98 cal 15°/g | PARKS, TODD and MOORE (1936) |

QUINOXALINE: $C_8H_6N_2$ and QUINALDINE (2-Methylquinoline): $CH_3.C_9H_6N$: *Boiling* and *melting point, density* and *refractive index*: BRÜHL (1895).

TETRAHYDROQUINOLINE: $C_9H_{11}N$: *Boiling point, density* and *magnetic rotatory power*: PERKIN (1896).

CARBAZOLE: $C_{12}H_9N$: *Saturated vapour pressure*: the values given by SENSEMAN and NELSON (1923) and by MORTIMER and MURPHY (1923) do not agree.

## PIPERIDINE $C_5H_{11}N$

**Constants:** B.E. (1937)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 35.84 | 50 | 48.34 | 90 | 78.54 | 300 | RILEY and BAILEY |
| 39.84 | 60 | 50.84 | 100 | 87.04 | 400 | „ (1930) |
| 42.84 | 70 | 67.64 | 200 | 106.34 | 760 | „ |
| 45.84 | 80 | | | | | „ |
| 19.50 | 22.8 | 23.93 | 29.1 | 30.00 | 40.2 | EWERT (1937) |
| 21.13 | 24.7 | 26.90 | 34.1 | 33.50 | 48.3 | „ |

*Boiling point*

| | | |
|---|---|---|
| 106°32 | | WALLIS (1906) |
| 106°40 | $\frac{dt}{dp}$ *(10 mm)*: | 0°44 B.E. (1937) |
| 106°4 | „ | 0°40 LECAT |

*Freezing point:* —10°5 EWERT (1937)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.87952 | B.E. (1937) | 25 | 0.8564 | KURNAKOW and SHEMTSHUSHNY |
| 15 | 0.86591 | „ | 50 | 0.8336 | „ (1913) |
| 30 | 0.85215 | „ | 80 | 0.8033 | „ |
| 0 | 0.87952 | EWERT (1937) | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 15 | 1679 | B.E. (1937) | 25 | 1362 | KURNAKOW and SHEMTSCHUSHNY |
| 30 | 1224 | „ | 50 | 845 | „ (1913) |
| 20 | 1486 | TSAKALOTOS (1909) | 80 | 738 | „ |
| 25 | 1370 | THOLE (1914) | | | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 30.64 | B.E. (1937) |
| 20 | 30.05 | „ |
| 30 | 28.81 | „ |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.45216 | 1.45248 | 1.45532 | 1.46037 | 1.46174 | 1.46563 | B.E. (1937) |
| $\frac{dn}{dt}$ | 0.00048 | 47 | 48 | 48 | 49 | 49 | „ |
| 15 | 1.45214 | — | 1.45530 | 1.46035 | — | 1.46556 | EWERT (1937) |

## NICOTINE $C_5H_4N.C_4H_7N(CH_3)$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 61.1 | 0.62 | 133.8 | 28.4 | 194.8 | 220.1 | YOUNG and NELSON |
| 61.4 | 0.57 | 140.1 | 37.4 | 198.9 | 248.0 | „ (1929) |
| 99.4 | 5.91 | 146.9 | 48.3 | 199.9 | 254.0 | „ |
| 99.7 | 5.97 | 155.0 | 64.7 | 212.3 | 343.0 | „ |
| 102.3 | 7.0 | 161.0 | 83.7 | 218.9 | 406.7 | „ |
| 106.9 | 9.0 | 170.0 | 104.1 | 225.1 | 473.3 | „ |
| 112.9 | 12.0 | 178.4 | 137.5 | 229.4 | 530.5 | „ |
| 116.7 | 14.9 | 184.5 | 164.3 | 236.1 | 623.2 | „ |
| 124.5 | 19.4 | 189.3 | 186.4 | 246.2 | 763.0 | „ |
| 25 | 0.0425 | 125 | 17 | — | — | NORTON, BIGELOW and VINCENT (1940) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 20 | 1.0093 | Lowry and Singh (1925) | 20 | 1.00925 | Jephcott (1919) |
| 20 | 1.0091 | Tsakalotos (1909) | 60 | 0.97799 | „ |
| 20 | 1.00924 | Ratz (1905) | 80 | 0.96184 | „ |
| | | | 97.7 | 0.94534 | „ |

*Viscosity:* $\eta \cdot 10^5$: 20° 4536 Tsakalotos (1909)

*Refractive index:* Gifford and Lowry (1927)

| λ | 15° | λ | 15° | λ | 15° | λ | 15° |
|---|---|---|---|---|---|---|---|
| 7685 | 1.520616 | 5893 | 1.529390 | 5270 | 1.535148 | 4471 | 1.546995 |
| 7065 | 1.522949 | 5608 | 1.531779 | 4861 | 1.540359 | 4413 | 1.548080 |
| 6708 | 1.524527 | 5461 | 1.532914 | 4678 | 1.543175 | 4341 | 1.549354 |
| 6503 | 1.525260 | | | | | | |

*Rotatory power*

| | | |
|---|---|---|
| $[\alpha]^{5461}_{20°}$ | −205°58 | Lowry and Lloyd (1929) (see original work) |
| $[\alpha]^{5461}_{20°}$ | −205° | Gifford and Lowry (1927) |
| $[\alpha]^{D}_{20°}$ | −169°22 | Ratz (1905) |
| | and | |
| $[\alpha]^{D}_{20°}$ | −169°54 | „ |
| $[\alpha]^{D}_{20°}$ | −168°90 | Norton, Bigelow and Vincent (1940) |

ANABASINE (nicotine isomer): $C_{10}H_{14}N_2$: *Saturated vapour pressure, density, refractive index* and *rotatory power:* Nelson (1934).

# 11. OXY-NITROGEN DERIVATIVES

## A. ALIPHATIC NITRO DERIVATIVES

### NITROMETHANE $CH_3NO_2$

**Constants:** B.E. (1932)

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 15.1 | 21.9 | JOUKOVSKY (1934) | 60 | 176.0 | HALBAN (1913) |
| 18.0 | 25.2 | „ | 70 | 262.5 | „ |
| 20.5 | 28.8 | „ | 80 | 375.0 | „ |
| 25.3 | 37.1 | „ | 85 | 450.0 | „ |
| 30.0 | 47.6 | „ | 90 | 531.5 | „ |
| | | | 95 | 623.5 | „ |
| | | | 100 | 744.5 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 101°0 | SMYTH and MAC ALPINE (1934) | 101°22 | $\frac{dt}{dp}$ *(10 mm):* 0°45 LECAT |
| 101°2 | WALDEN (1903) | 101°25 | „ 0°44 B.E. (1932) |

*Freezing point:* —28°6

*Critical solution point in $CS_2$:* 63°3

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.16490 | B.E. (1932) | 25 | 1.1311 | GROVES and SUGDEN (1937) |
| 15 | 1.14476 | „ | 25 | 1.1312 | WRIGHT, MURRAY-RUST and HARTLEY (1931) |
| 30 | 1.12453 | „ | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 694 | B.E. (1932) |
| 30 | 595 | „ |
| 25 | 627 | WRIGHT, MURRAY-RUST and HARTLEY (1931) |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 37.74 | B.E. (1932) |
| 20 | 36.98 | „ |
| 30 | 35.51 | „ |
| 20 | 36.82 | Harkins, Clark and Roberts (1920) |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.38090 | 1.38139 | — | 1.38411 | 1.38911 | 1.39058 | 1.39462 | B.E. (1932) |
| $\frac{dn}{dt}$ | 0.00041 | 42 | — | 42 | 42 | 43 | 43 | „ |
| 16 | — | — | — | 1.38386 | — | — | — | Joukovsky (1934) |
| 20 | — | — | 1.38195 | — | — | — | — | Smyth and Mac Alpine (1934) |

TETRANITROMETHANE: $C(NO_2)_4$: *Feezing point, density* and *refractive index:* Nicholson (1949).

1-NITRO-*n*-PENTANE: $C_5H_{11}NO_2$ and 1-NITRO-*iso*-PENTANE: $(CH_3)_2CH.(CH_2)_2NO_2$: *Boiling point, density* and *viscosity:* Friend and Hargreaves (1943).

ETHYL NITRITE: $C_2H_5NO_2$ and *n*-PROPYL NITRITE. *n*-$C_3H_7NO_2$: *Boiling point, density* and *viscosity:* Friend and Hargreaves (1943); *boiling point:* Lecat

## ETHYLENE GLYCOL DINITRATE $(CH_2NO_3)_2$

### Constants

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 0 | 0.0044 | Marshall (1930) | 60 | 1.3 | Marshall (1930) |
| 20 | 0.038 | „ | 80 | 5.9 | „ |
| 40 | 0.26 | „ | 100 | 22.0 | „ |

*Freezing point:* −22°3 Rinkenbach (1927)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 4 | 1.5099 | PERKIN (1889) | 20 | 1.4882 | PERKIN (1889) |
| 10 | 1.5012 | „ | 25 | 1.4817 | „ |
| 15 | 1.4947 | „ | 15 | 1.4943 | PETERSON (1930) |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 10.0 | 573 | PETERSON (1930) | 40.0 | 260 | PETERSON (1930) |
| 15.0 | 487 | „ | 45.0 | 236 | „ |
| 20.0 | 421 | „ | 50.0 | 214 | „ |
| 25.0 | 369 | „ | 55.0 | 195 | „ |
| 30.0 | 329 | „ | 60.0 | 182 | „ |
| 35.0 | 292 | „ | | | |

*Refractive index*

| t° | $n_D$ | | t° | $n_D$ | |
|---|---|---|---|---|---|
| 15.0 | 1.4491 | RINKENBACH (1927) | 20.0 | 1.4472 | RINKENBACH (1927) |
| 25.0 | 1.4454 | „ | 30.0 | 1.4435 | „ |

## DIETHYLENE GLYCOL DINITRATE $(NO_3\,CH_2.CH_2)_2\,O$

**Constants:** RINKENBACH (1927)

*Saturated vapour pressure:* 22°4 0.007 mm

*Freezing point:* −11°3

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0.0 | 1.4090 | RINKENBACH (1927) | 20.0 | 1.3831 | RINKENBACH (1927) |
| 5.0 | 1.4030 | „ | 25.0 | 1.3745 | „ |
| 10.0 | 1.3965 | „ | 30.0 | 1.3664 | „ |
| 15.0 | 1.3896 | „ | 15.0 | 1.3889 | PETERSON (1930) (sic.) |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 10 | 1190 | PETERSON (1930) | 40 | 437 | PETERSON (1930) |
| 15 | 970 | „ | 45 | 383 | „ |
| 20 | 808 | „ | 50 | 351 | „ |
| 25 | 673 | „ | 55 | 306 | „ |
| 30 | 573 | „ | 60 | 275 | „ |
| 35 | 496 | „ | | | |

*Refractive index*

| t° | $n_D$ | | t° | $n_D$ | |
|---|---|---|---|---|---|
| 0.0 | 1.4593 | RINKENBACH (1927) | 20.0 | 1.4517 | RINKENBACH (1927) |
| 5.0 | 1.4574 | „ | 25.0 | 1.4498 | „ |
| 10.0 | 1.4555 | „ | 30.0 | 1.4479 | „ |
| 15.0 | 1.4536 | „ | 35.0 | 1.4460 | „ |

## PROPYLENE GLYCOL DINITRATE
$CH_3.CHNO_3.CH_2NO_3$

## TRIMETHYLENE GLYCOL DINITRATE
$NO_3CH_2.CH_2.CH_2NO_3$

**Constants:** PETERSON (1930)

*Density:* 15° 1.3927

15° 1.4695

*Viscosity*

| t° | $\eta \cdot 10^4$ | t° | $\eta \cdot 10^4$ | t° | $\eta \cdot 10^4$ | t° | $\eta \cdot 10^4$ |
|---|---|---|---|---|---|---|---|
| 10 | 556 | 40 | 246 | 10 | 851 | 40 | 344 |
| 15 | 476 | 45 | 221 | 15 | 706 | 45 | 310 |
| 20 | 407 | 50 | 203 | 20 | 597 | 50 | 282 |
| 25 | 355 | 55 | 183 | 25 | 501 | 55 | 258 |
| 30 | 314 | 60 | 171 | 30 | 436 | 60 | 233 |
| 35 | 278 | | | 35 | 388 | | |

## GLYCERYL TRINITRATE or NITROGLYCERIN $CH_2NO_3.CHNO_3.CH_2NO_3$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 20.0 | 0.00025 | 50.0 | 0.0072 | 80.0 | 0.096 | Marshall and Peace (1916) |
| 30.0 | 0.00083 | 60.0 | 0.0188 | 90.0 | 0.230 | „ |
| 40.0 | 0.0024 | 70.0 | 0.043 | 93.4 | 0.30 | „ |
| 20 | 0.00024 | | | | | Chiaraviglio and Carbino (1916) |

*Freezing point*

| | | | | |
|---|---|---|---|---|
| *Labile form* | 1°9 | *Stable form* | 13°0 | Hackel (1936) |
| „ | 2°0 | „ | 13°1 | Hibbert (1912–14) |
| „ | 2°1 | „ | 13°2 | Kast (1906) |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 4 | 1.6144 | Perkin (1889) | 20 | 1.5939 | Perkin (1889) |
| 10 | 1.6064 | „ | 25 | 1.5862 | „ |
| 15 | 1.5995 | „ | 15 | 1.5964 | Peterson (1930) |

*Viscosity*

| t° | $\eta \cdot 10^3$ | | t° | $\eta \cdot 10^3$ | |
|---|---|---|---|---|---|
| 10 | 692 | Peterson (1930) | 40 | 136 | Peterson (1930) |
| 15 | 491 | „ | 45 | 112 | „ |
| 20 | 360 | „ | 50 | 93.8 | „ |
| 25 | 270 | „ | 55 | 79.2 | „ |
| 30 | 210 | „ | 60 | 68.0 | „ |
| 35 | 168 | „ | | | |

*Surface tension:* 20° 51.1 Sutton and Harden (1934)

| | | |
|---|---|---|
| *Heat of combustion* | 20° ($c_v$) 1615 cal 15°/g | Taylor and Halle (1947) |
| | „ ($c_p$) 1603 „ | „ |

## B. ALIPHATIC AMIDES

### FORMAMIDE $H.CONH_2$

This product is purified by distillation at reduced pressure and by fractional fusion.

**Constants:** B.E. (1935):

*Freezing point*

| | | | |
|---|---|---|---|
| 2°55 | Smith (1931) | 2°55 | Smith (1940) |
| 2°55 | B.E. (1935) and Deffet (1935) | | |

*Melting curve*

| t° | p kg/cm² | | t° | p kg/cm² | |
|---|---|---|---|---|---|
| 2.55 | 1 | Deffet (1935) | 10.00 | 820 | Deffet (1935) |
| 5.00 | 270 | „ | 12.50 | 1085 | „ |
| 7.50 | 540 | „ | | | |

*Density* *Viscosity* *Surface tension*

| t° | d | t° | $\eta \cdot 10^5$ | t° | $\gamma$ | |
|---|---|---|---|---|---|---|
| 15 | 1.13756 | 15 | 4320 | — | — | B.E. (1935) |
| 20 | 1.13340 | 30 | 2926 | — | — | „ |
| 30 | 1.12483 | | | | | „ |
| 18 | 1.13510 | 18 | 3970 | 18 | 58.53 | Smith (1931) |
| 20 | 1.13339 | 20 | 3764 | 20 | 58.35 | „ |
| 25 | 1.12918 | 25 | 3302 | 25 | 57.91 | „ |
| 35 | 1.12068 | | | 35 | 57.11 | „ |
| | | | | 50 | 55.72 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.44052 | 1.44565 | 1.44911 | 1.44928 | 1.45574 | 1.45754 | 1.46253 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00032 | 32 | — | 32 | 32 | 33 | 35 | „ |
| 20 | — | — | 1.44754 | — | — | — | — | Smith (1940) |
| 110 | 1.4134 | — | 1.4170 | 1.4171 | 1.4230 | — | 1.4291 | Bruylants (1939) |
| 130 | 1.4060 | — | 1.4095 | 1.4096 | 1.4155 | — | 1.4213 | „ |

Smith (1940) gives a series of values for other wave-lengths.

| ACETAMIDE $CH_3.CONH_2$ | | | PROPIONAMIDE $CH_3.CH_2.CONH_2$ | | |
|---|---|---|---|---|---|
| **Constants** | | | | | |
| *Boiling point* | 221°15 | | 222°2 | | LECAT |
| *Density* | — | | 110° | 0.9262 | BRUYLANTS (1939) |
| | — | | 130° | 0.9093 | „ |
| *Refractive index* | 110° | 130° | 110° | 130° | |
| He r. | 1.4126 | 1.4048 | 1.4130 | 1.4053 | BRUYLANTS (1932) |
| D | 1.4158 | 1.4079 | 1.4160 | 1.4082 | „ |
| He y. | 1.4159 | 1.4080 | 1.4161 | 1.4083 | „ |
| He g. | 1.4214 | 1.4132 | 1.4211 | 1.4132 | „ |
| He v. | 1.4268 | 1.4185 | 1.4261 | 1.4180 | „ |

## CARBAMIDE or UREA $CO(NH_2)_2$

**Constants**

*Melting point*

| | |
|---|---|
| 132°65 | SHNIDMAN and SUNIER (1932) |
| 132°7 | SPEYERS (1896) |
| 132°8 | HRYNAKOWSKI and SMOCZKIEWIECZOWNA (1937) |

*Specific heat:* RUEHRWEIN and HUFFMAN (1946) (M.W. 60.058)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| −253.71 | 0.01896 | −209.68 | 0.1189 | −120.73 | 0.2170 | −6.72 | 0.3363 |
| −252.63 | 0.02141 | −205.89 | 0.1247 | −109.81 | 0.2283 | −4.50 | 0.3389 |
| −251.07 | 0.02546 | −200.95 | 0.1316 | − 99.35 | 0.2393 | −0.62 | 0.3437 |
| −247.91 | 0.03373 | −194.98 | 0.1396 | − 89.29 | 0.2499 | +0.84 | 0.3449 |
| −243.60 | 0.04527 | −189.39 | 0.1470 | − 79.59 | 0.2600 | 3.23 | 0.3472 |
| −239.80 | 0.05535 | −185.24 | 0.1516 | − 70.21 | 0.2698 | 8.26 | 0.3523 |
| −236.34 | 0.06424 | −184.10 | 0.1530 | − 62.66 | 0.2780 | 8.90 | 0.3533 |
| −232.48 | 0.07349 | −180.14 | 0.1577 | − 55.41 | 0.2852 | 15.56 | 0.3600 |
| −228.59 | 0.08242 | −173.82 | 0.1636 | − 46.78 | 0.2938 | 16.36 | 0.3614 |
| −224.64 | 0.09119 | −166.37 | 0.1710 | − 38.35 | 0.3025 | 23.67 | 0.3692 |
| −220.57 | 0.09917 | −159.27 | 0.1781 | − 30.12 | 0.3111 | 30.86 | 0.3771 |
| −217.19 | 0.1057 | −151.85 | 0.1856 | − 24.19 | 0.3177 | 37.91 | 0.3844 |
| −216.44 | 0.1070 | −143.06 | 0.1943 | − 22.07 | 0.3196 | 44.85 | 0.3920 |
| −213.74 | 0.1119 | −132.21 | 0.2055 | | | | |

## SATURATED and UNSATURATED AMIDES

*Refractive index* $R.CH_2.CH_2.CONH_2$

| | t° | He r. | D | He y. | He g. | He v. | He r. | D |
|---|---|---|---|---|---|---|---|---|
| $R=CH_3$ | 110 | 1.4135 | 1.4165 | 1.4167 | 1.4217 | 1.4264 | 1.4564 | 1.4610 |
| | 116 | — | — | — | — | — | 1.4539 | 1.4584 |
| | 120 | 1.4097 | 1.4116 | 1.4127 | 1.4176 | 1.4223 | — | — |
| | 130 | 1.4059 | 1.4087 | 1.4087 | 1.4135 | 1.4182 | 1.4481 | 1.4525 |
| | 165 | — | — | — | — | — | — | — |
| $R=C_2H_5$ | 90 | — | — | — | — | — | 1.4581 | 1.4624 |
| | 110 | 1.4155 | 1.4183 | 1.4184 | 1.4232 | 1.4279 | 1.4499 | 1.4542 |
| | 130 | 1.4077 | 1.4104 | 1.4104 | 1.4152 | 1.4199 | — | — |
| | 155 | — | — | — | — | — | — | — |
| $R=n\text{-}C_3H_7$ | 90 | — | — | — | — | — | 1.4552 | 1.4592 |
| | 110 | 1.4172 | 1.4200 | 1.4200 | 1.4248 | 1.4294 | 1.4470 | 1.4510 |
| | 130 | 1.4096 | 1.4123 | 1.4124 | 1.4171 | 1.4217 | — | — |
| | 140 | — | — | — | — | — | — | — |
| $R=n\text{-}C_4H_9$ | 90 | — | — | — | — | — | 1.4529 | 1.4569 |
| | 110 | 1.4190 | 1.4217 | 1.4218 | 1.4265 | 1.4310 | 1.4444 | 1.4483 |
| | 130 | 1.4115 | 1.4142 | 1.4142 | 1.4188 | 1.4233 | — | — |
| | 140 | — | — | — | — | — | — | — |
| $R=n\text{-}C_5H_{11}$ | 90 | — | — | — | — | — | 1.4515 | 1.4554 |
| | 110 | 1.4205 | 1.4232 | 1.4234 | 1.4281 | 1.4326 | 1.4433 | 1.4470 |
| | 130 | 1.4133 | 1.4160 | 1.4161 | 1.4207 | 1.4251 | — | — |
| | 140 | — | — | — | — | — | — | — |
| $R=n\text{-}C_6H_{13}$ | 90 | — | — | — | — | — | 1.4506 | 1.4543 |
| | 110 | 1.4221 | 1.4248 | 1.4249 | 1.4295 | 1.4340 | 1.4426 | 1.4461 |
| | 130 | 1.4147 | 1.4174 | 1.4175 | 1.4220 | 1.4264 | — | — |
| | 140 | — | — | — | — | — | — | — |
| $R=n\text{-}C_7H_{15}$ | 90 | — | — | — | — | — | 1.4499 | 1.4535 |
| | 110 | 1.4234 | 1.4261 | 1.4262 | 1.4308 | 1.4355 | 1.4420 | 1.4455 |
| | 130 | 1.4162 | 1.4188 | 1.4189 | 1.4234 | 1.4278 | — | — |
| | 140 | — | — | — | — | — | — | — |
| $R=n\text{-}C_8H_{17}$ | 90 | — | — | — | — | — | 1.4493 | 1.4528 |
| | 110 | 1.4246 | 1.4272 | 1.4273 | 1.4319 | 1.4364 | 1.4415 | 1.4450 |
| | 130 | 1.4172 | 1.4198 | 1.4199 | 1.4244 | 1.4288 | — | — |
| | 140 | — | — | — | — | — | — | — |
| $R=n\text{-}C_9H_{19}$ | 110 | 1.4259 | 1.4287 | 1.4288 | 1.4333 | 1.4378 | — | — |
| | 130 | 1.4188 | 1.4214 | 1.4215 | 1.4260 | 1.4304 | — | — |

**Constants:** BRUYLANTS (1939)

$RCH{=}CH.CONH_2$ *Refractive index*

| *Cis* | | | *Trans* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| He y. | He g. | He v. | He r. | D | He y. | He g. | He v. | t° | |
| 1.4612 | 1.4690 | 1.4770 | — | — | — | — | — | 110 | R=$CH_3$ |
| 1.4586 | 1.4664 | 1.4744 | — | — | — | — | — | 116 | |
| — | — | — | — | — | — | — | — | 120 | |
| 1.4526 | 1.4604 | 1.4683 | — | — | — | — | — | 130 | |
| — | — | — | 1.4375 | 1.4420 | 1.4421 | 1.4499 | 1.4578 | 165 | |
| 1.4626 | 1.4702 | 1.4780 | — | — | — | — | — | 90 | R=$C_2H_5$ |
| 1.4542 | 1.4617 | 1.4692 | — | — | — | — | — | 110 | |
| — | — | — | — | — | — | — | — | 130 | |
| — | — | — | 1.4377 | 1.4418 | 1.4419 | 1.4493 | 1.4579 | 155 | |
| 1.4594 | 1.4666 | 1.4739 | — | — | — | — | — | 90 | R=*n*-$C_3H_7$ |
| 1.4511 | 1.4582 | 1.4652 | — | — | — | — | — | 110 | |
| — | — | — | 1.4437 | 1.4478 | 1.4479 | 1.4551 | 1.4624 | 130 | |
| — | — | — | 1.4400 | 1.4440 | 1.4441 | 1.4512 | 1.4585 | 140 | |
| 1.4570 | 1.4639 | 1.4708 | — | — | — | — | — | 90 | R=*n*-$C_4H_9$ |
| 1.4484 | 1.4552 | 1.4620 | — | — | — | — | — | 110 | |
| — | — | — | 1.4415 | 1.4454 | 1.4455 | 1.4525 | 1.4594 | 130 | |
| — | — | — | 1.4375 | 1.4414 | 1.4415 | 1.4483 | 1.4553 | 140 | |
| 1.4555 | 1.4620 | 1.4687 | — | — | — | — | — | 90 | R=*n*-$C_5H_{11}$ |
| 1.4471 | 1.4535 | 1.4599 | — | — | — | — | — | 110 | |
| — | — | — | — | — | — | — | — | 130 | |
| — | — | — | 1.4362 | 1.4400 | 1.4401 | 1.4466 | 1.4531 | 140 | |
| 1.4544 | 1.4609 | 1.4673 | — | — | — | — | — | 90 | R=*n*-$C_6H_{13}$ |
| 1.4462 | 1.4525 | 1.4589 | — | — | — | — | — | 110 | |
| — | — | — | — | — | — | — | — | 130 | |
| — | — | — | 1.4352 | 1.4387 | 1.4387 | 1.4451 | 1.4514 | 140 | |
| 1.4535 | 1.4598 | 1.4661 | — | — | — | — | — | 90 | R=*n*-$C_7H_{15}$ |
| 1.4456 | 1.4517 | 1.4579 | — | — | — | — | — | 110 | |
| — | — | — | 1.4384 | 1.4419 | 1.4419 | 1.4482 | 1.4544 | 130 | |
| — | — | — | 1.4342 | 1.4377 | 1.4378 | 1.4439 | 1.4501 | 140 | |
| 1.4529 | 1.4590 | 1.4652 | — | — | — | — | — | 90 | R=*n*-$C_8H_{17}$ |
| 1.4451 | 1.4510 | 1.4570 | — | — | — | — | — | 110 | |
| — | — | — | 1.4371 | 1.4405 | 1.4406 | 1.4466 | 1.4527 | 130 | |
| — | — | — | 1.4336 | 1.4370 | 1.4370 | 1.4431 | 1.4491 | 140 | |
| — | — | — | — | — | — | — | — | 110 | R=*n*-$C_9H_{19}$ |
| — | — | — | — | — | — | — | — | 130 | |

*Sublimation pressure*

| | $R.CH_2.CH_2.CONH_2$ | | $R.CH=CH.CONH_2$ | | | |
|---|---|---|---|---|---|---|
| | | | *Cis* | | *Trans* | |
| | t° | p mm | t° | p mm | t° | p mm |
| $R=CH_3$ | 70.00 | 0.52 | 50.05 | 0.59 | 90.00 | 0.53 |
| | 80.00 | 0.95 | 60.00 | 0.73 | 99.95 | 1.27 |
| | 90.00 | 2.10 | 70.05 | 0.94 | 109.90 | 2.41 |
| | 99.95 | 4.28 | 79.95 | 1.42 | 120.05 | 4.08 |
| | 110.05 | 8.15 | 90.05 | 2.43 | 129.95 | 7.22 |
| | | | 100.00 | 4.30 | 140.00 | 12.90 |
| | | | 110.00 | 8.29 | | |
| | | | 113.95 | 10.76 | | |
| $R=C_2H_5$ | 80.00 | 0.51 | 50.00 | 0.07 | 80.00 | 0.53 |
| | 90.00 | 1.27 | 60.00 | 0.23 | 89.95 | 1.09 |
| | 100.05 | 2.59 | 70.00 | 0.43 | 100.05 | 1.83 |
| | | | 80.00 | 0.95 | 110.00 | 2.66 |
| | | | 89.80 | 1.96 | 119.95 | 3.86 |
| | | | 100.00 | 3.56 | 129.95 | 6.38 |
| | | | 110.05 | 6.49 | 140.10 | 10.69 |
| $R=n\text{-}C_3H_7$ | 94.90 | 0.70 | 50.00 | 0.09 | 80.00 | 0.56 |
| | | | 60.00 | 0.22 | 89.90 | 1.04 |
| | | | 70.00 | 0.42 | 100.00 | 1.79 |
| | | | 80.00 | 0.86 | 110.00 | 2.75 |
| | | | 90.10 | 1.43 | 120.00 | 3.84 |
| | | | 100.00 | 2.45 | | |
| | | | 110.00 | 4.18 | | |
| $R=n\text{-}C_4H_9$ | 94.90 | 0.56 | — | — | 89.95 | 0.14 |
| | | | | | 100.00 | 0.38 |
| | | | | | 109.95 | 0.86 |
| | | | | | 120.00 | 1.63 |
| $R=n\text{-}C_5H_{11}$ | 94.90 | 0.17 | — | — | 89.90 | 0.23 |
| | | | | | 100.00 | 0.50 |
| | | | | | 109.90 | 0.89 |
| | | | | | 120.00 | 1.67 |
| $R=n\text{-}C_6H_{13}$ | — | | — | — | 110.05 | 0.30 |
| | | | | | 120.00 | 0.73 |

$R.CH_2.CH_2.CONH_2$ $R.CH=CH.CONH_2$

| | | *Cis* | *Trans* |
|---|---|---|---|
| *Melting point* | | | |
| $R=CH_3$ | | 116°0 | 115°8 | 157°2 |
| $R=C_2H_5$ | | 105°2 | 68°1 | 152°0 |
| $R=n\text{-}C_3H_7$ | | 101°0 | 68°6 | 124°8 |
| $R=n\text{-}C_4H_9$ | | 96°6 | 74°0 | 125°1 |
| $R=n\text{-}C_5H_{11}$ | | 106°6 | 74°6 | 135°1 |
| $R=n\text{-}C_6H_{13}$ | | 99°7 | 74°5 | 131°7 |
| $R=n\text{-}C_7H_{15}$ | | 99°2 | 76°2 | 123°5 |
| $R=u\text{-}C_8H_{17}$ | | 99°0 | 77°2 | 115°5 |
| *Density* | | | | | |
| | t° | d | t° | d | t° | d |
| $R=CH_3$ | 120 | 0.8850 | 120 | 0.9461 | — | — |
| | 130 | 0.8767 | 130 | 0.9370 | — | — |
| $R=C_2H_5$ | 110 | 0.8735 | 90 | 0.9303 | — | — |
| | 130 | 0.8576 | 110 | 0.9144 | — | — |
| $R=n\text{-}C_3H_7$ | 110 | 0.8606 | 90 | 0.9099 | 130 | 0.8831 |
| | 130 | 0.8456 | 110 | 0.8947 | 140 | 0.8748 |
| $R=n\text{-}C_4H_9$ | 110 | 0.8521 | 90 | 0.8945 | 130 | 0.8683 |
| | 130 | 0.8365 | 110 | 0.8795 | 140 | 0.8606 |
| $R=n\text{-}C_5H_{11}$ | 110 | 0.8450 | 90 | 0.8836 | | |
| | 130 | 0.8304 | 110 | 0.8688 | 140 | 0.8508 |
| $R=n\text{-}C_6H_{13}$ | 110 | 0.8394 | 90 | 0.8749 | | |
| | 130 | 0.8254 | 110 | 0.8604 | 140 | 0.8424 |
| $R=n\text{-}C_7H_{15}$ | 110 | 0.8359 | 90 | 0.8683 | 130 | 0.8436 |
| | 130 | 0.8329 | 110 | 0.8542 | 140 | 0.8361 |
| $R=n\text{-}C_8H_{17}$ | 110 | 0.8223 | 90 | 0.8627 | 130 | 0.8382 |
| | 130 | 0.8190 | 110 | 0.8493 | 140 | 0.8309 |

## AMINO-ACIDS and DERIVATIVES

*d-l*-ALANINE: $CH_3—CH(NH_2)—CO_2H$; *d-l*-LEUCINE: $(CH_3)_2$ $CH—CH_2—CH(NH_2)—CO_2H$; *d*-ARGININE: $NH_2—C(NH)—NH—(CH_2)_3—CHNH_2—CO_2H$; *l*-TYROSINE: $C_6H_4(OH)CH_2—CH(NH_2)CO_2H$: *Specific heat* and *heat of combustion:* HUFFMAN, FOX and ELLIS (1936–37); CREATINE HYDRATE: $NH=C(NH_2)—N(CH_3)CH_2—CO_2H.H_2O$; *d-l*-CITRULLINE: $H_2N—CO—NH—(CH_2)_3—CH(NH_2)—CO_2H$; *d-l*-ORNITHINE: $CH_2NH_2—CH_2—CH_2—CHNH_2—CO_2H$; *l*-PROLINE: $C_4H_8N.CO_2H$: *Specific heat:* HUFFMAN and FOX (1940); *d-l*-ALANYLGLYCINE: $CH_3—CH(NH_2)—CO—NH—CH_2—CO_2H$; HIPPURIC ACID: $CO_2H—CH_2—NH—COC_6H_5$; GLYCYLGLYCINE: $H_2N—CH_2—CO—NH—CH_2—CO_2H$; *d-l*-LEUCYLGLYCINE: $(CH_3)_2CH—CH_2—CH(NH_2)—CO—NH—CH_2—CO_2H$; HIPPURYLGLYCINE: $C_6H_5—CO—NH—CH_2—CO—NH—CH_2—CO_2H$: *Specific heat:* HUFFMAN (1941); GUANIDINE CARBONATE: $(NH=C(NH_2)_2)_2H_2CO_3$: *Specific heat:* HUFFMAN, ELLIS and BORSOOK (1940).

## C. MISCELLANEOUS DERIVATIVES

### MONOETHANOLAMINE $\begin{matrix}CH_2OH\\|\\CH_2NH_2\end{matrix}$

**Constants:** Reitmeier, Sivertz and Tartar (1940)

*Boiling point:* 170°8 Lecat
171°1

*Melting point:* 10°5

*Density* *Surface tension*

| t° | d | t° | d | t° | $\gamma$ | t° | $\gamma$ |
|---|---|---|---|---|---|---|---|
| 25 | 1.01170 | 60 | 0.98366 | 25 | 48.30 | 60 | 44.41 |
| 30 | 1.00773 | 70 | 0.97551 | 30 | 47.79 | 70 | 43.29 |
| 40 | 0.99983 | 80 | 0.96749 | 40 | 46.59 | 80 | 42.18 |
| 50 | 0.99182 | | | 50 | 45.59 | | |

*Refractive index:* $n_D^{20°}$ 1.4539

### CYANIC ACID N≡C.OH

**Constants**

*Saturated vapour pressure:* Linhard (1938)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| −76.27 | 1.28 | −59.86 | 5.88 | −39.34 | 27.71 | −23.97 | 74.72 |
| −74.97 | 1.39 | −57.92 | 6.72 | −38.52 | 29.38 | −21.14 | 88.30 |
| −73.80 | 1.57 | −54.13 | 8.80 | −35.93 | 35.11 | −21.12 | 88.46 |
| −72.12 | 1.95 | −52.56 | 10.55 | −34.76 | 38.10 | −17.99 | 105.86 |
| −70.25 | 2.25 | −50.22 | 12.71 | −32.19 | 44.97 | −14.97 | 125.19 |
| −68.21 | 2.79 | −48.47 | 14.47 | −30.09 | 51.33 | −11.63 | 150.66 |
| −66.77 | 3.20 | −45.43 | 18.02 | −29.74 | 52.63 | − 8.63 | 175.68 |
| −64.36 | 3.97 | −43.46 | 20.75 | −26.80 | 62.91 | − 5.94 | 201.98 |
| −62.22 | 4.78 | −40.60 | 25.50 | | | | |

## ETHYL CARBAMATE or URETHAN $NH_2.CO_2C_2H_5$

### Constants

*Saturated vapour pressure:* STUCKGOLD (1917)

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 103.0 | 54.0 | 163.0 | 429.2 | 172.7 | 616.2 |
| 120.7 | 108.0 | 168.9 | 526.0 | 175.0 | 645.0 |
| 130.1 | 146.5 | 171.1 | 574.1 | 176.8 | 696.7 |
| 141.7 | 214.3 | | | | |

*Boiling point:* 185°25 LECAT

*Melting point:* 48°19 CHADWELL and ASNES (1930)

*Density and Viscosity*

| t° | d | $\eta \cdot 10^5$ | | t° | d | |
|---|---|---|---|---|---|---|
| 60 | 1.0482 | 2357 | STUCKGOLD | 48.2 | 1.0599 | TURNER and POLLARD (1914) |
| 70 | 1.0381 | 1805 | „ (1917) | | | |
| 80 | 1.0280 | 1456 | „ | | | |

*o-m-,p*-AMINOBENZOIC ACIDS: *o-m-*,p,-$NH_2.C_6H_4.CO_2H$, and HYDROXYACETANILIDE: $C_6H_5NH.CO.CH_2OH$: *Heat of melting, specific heat:* ANDREWS, LYNN and JOHNSTON (1926).

AROMATIC AMIDES. The *density* and the *surface tension* of the following amides were studied by TURNER and MERRY (1910), but there are no comparison data.

| | |
|---|---|
| BENZAMIDE (M.P.: 127°2 SKAU, (1935) | $C_6H_5.CONH_2$ |
| PHENYLACETAMIDE | $CH_2(C_6H_5).CONH_2$ |
| SALICYLAMIDE | $C_6H_4(OH).CONH_2$ |
| FORMANILIDE | $C_6H_5NH.COH$ |
| METHYLACETANILIDE | $C_6H_5N(CH_3).CO.CH_3$ |
| ETHYLACETANILIDE | $C_6H_5N(C_2H_5).CO.CH_3$ |
| N-PHENYLURETHAN (ETHYL CARBANILATE) | $C_6H_5NH.CO_2C_2H_5$ |

ACETANILIDE: $C_6H_5NH.CO.CH_3$: *Melting point, density* and *surface tension:* GRINAKOWSKY (1913) and TURNER and MERRY (1910). Criteria for the impurities: *melting point*: SCHWAB and WICHERS (1944).

ANTIPYRINE or PHENAZONE: $C_{11}H_{12}N_2O$: *melting point, density* and *surface tension:* GRINAKOWSKI (1913).

## *p*-AZOXYANISOLE

$CH_3.O.C_6H_4—N(\rightarrow O)—N—C_6H_4.O.CH_3$

*Melting point*

| | | | |
|---|---|---|---|
| 117°8 | Robberecht (1938) | 118°5 | Prins (1909) |
| 118°3 | Hulett (1899) | 118°5 | Svedberg (1914) |

*Transition point* in the liquid phase (clearing point)

| | | | |
|---|---|---|---|
| 135°5 | Prins (1909) | 135°9 | Robberecht (1938) |
| 135°6 | Svedberg (1914) | 136° | Pick (1911) |
| 135°9 | Hulett (1899) | | |

*Melting curve*

| *Fusion* | | *Transition* | | |
|---|---|---|---|---|
| t° | p kg/cm² | t° | p kg/cm² | |
| 117.8 | 1 | 135.9 | 1 | Robberecht (1938) |
| 118.8 | 25 | 136.8 | 19 | „ |
| 120 | 60 | 137.6 | 35 | „ |
| 120.8 | 85 | 138.7 | 58 | „ |
| 128.2 | 310 | 140.8 | 107 | „ |
| 134.8–134.9 | 500 | 142.3 | 130 | „ |
| 148.4 | 600 | 145.4 | 200 | „ |

ETHYL *p*-AZOXYBENZOATE: $C_2H_5CO_2C_6H_4—N(\rightarrow O)—N—C_6H_4.CO_2.C_2H_5$:

*Melting point* and *specific heat:* Spaght, Thomas and Parks (1932).

# D. AROMATIC NITRO DERIVATIVES

## NITROBENZENE $C_6H_5NO_2$

Nitrobenzene is purified by distillation followed by fractional crystallization. The critical temperature of solution in $n$-$C_6H_{14}$ is a very sensitive criterion of purity.

**Constants:** B.E. (1935). **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | | t° | p mm | |
|---|---|---|---|---|---|
| 25 | 0.340 | Brückner (1931) | 69.2 | 4 | Kahlbaum (1898) |
| 30 | 0.425 | „ | 72.9 | 5 | „ |
| 35 | 0.523 | „ | 76.1 | 6 | „ |
| 50 | 0.951 | „ | 79.1 | 7 | „ |
| 51.2 | 1.00 | „ | 81.5 | 8 | „ |
| 53.1 | 1 | Kahlbaum (1898) | 83.5 | 9 | „ |
| 59.8 | 2 | „ | 85.4 | 10 | „ |
| 64.9 | 3 | „ | 120.2 | 50 | „ |

*Boiling point*

| | | | |
|---|---|---|---|
| 210°75 | $\frac{dt}{dp}$ *(10 mm):* | 0°48 | Lecat |
| 210°8 | | | Perkin (1896) |
| 210°85 | „ | 0°48 | B.E. (1935) |

*Melting point*

| | | | |
|---|---|---|---|
| 5°66 | Turner and Pollard (1914) | 5°70 | B.E. (1935) and Deffet (1935) |
| 5°668 | Roberts and Bury (1923) | 5°72 | Sugden (1933) |
| 5°67 | Murakami (1932) | 5°76 | Cohen and Boekhorst (1934) |
| 5°67 | Swarts (1914) | 5°77 | Massy, Warren and Wolfenden (1932) |
| 5°689 | Sidgwick and Ewbank (1924) | | |
| 5°7 | Udovenko and Ayrapetova (1947) | 5°82 | Meyer (1910) |
| 5°70 | Simpson and Jones (1919) | | |

*Melting curve*

| t° | p kg/cm² | t° | p kg/cm² | |
|---|---|---|---|---|
| 5.70 | 1 | 20.00 | 650 | Deffet (1935) |
| 10.05 | 198 | 25.00 | 875 | „ |
| 15.00 | 423 | 27.50 | 988 | „ |

*Critical solution point in n-hexane*: 21°0

## Constants of state

*Density* (Liquid state)

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.22305 | B.E. (1935) | 20 | 1.2032 | Perkin (1896) |
| 15 | 1.20834 | „ | 25 | 1.1985 | „ |
| 30 | 1.19341 | „ | 30 | 1.1936 | „ |
| 4 | 1.2193 | Perkin (1896) | 35 | 1.1894 | „ |
| 5 | 1.2181 | „ | 40 | 1.1837 | „ |
| 10 | 1.2131 | „ | 45 | 1.1786 | „ |
| 15 | 1.20826 | „ | 50 | 1.1740 | „ |
| 0 | 1.22290 | Timmermans (1910) | 25 | 1.1982 | Sugden (1933) |
| 18 | 1.20538 | Dawson (1910) | 25 | 1.1983 | Gibson and Loeffler (1939) |
| 20 | 1.2032 | Brückner (1931) | | | |
| 20 | 1.20323 | Tyrer (1914) | 25 | 1.1983 | Coates and Coates (1944) |
| 20 | 1.2033 | Brand and Kranz (1927) | 25 | 1.19849 | Martin and George (1933) |
| 20 | 1.20340 | Biron and Morgoulewa (1914) | 25 | 1.19861 | Le Fevre and Le Fevre (1936) |
| 20 | 1.2034 | Herzen (1902) | | | |

| t° | d | t° | d | t° | d | t° | d | |
|---|---|---|---|---|---|---|---|---|
| 1.36 | 1.22175 | 5.45 | 1.21769 | 8.93 | 1.21427 | 13.44 | 1.20978 | Cohen and Boekhorst |
| 2.35 | 1.22076 | 5.96 | 1.21721 | 9.43 | 1.21375 | 14.44 | 1.20879 | „ (1934) |
| 2.95 | 1.22017 | 6.43 | 1.21672 | 9.93 | 1.21327 | 15.45 | 1.20781 | „ |
| 3.54 | 1.21959 | 6.94 | 1.21623 | 10.43 | 1.21278 | 16.35 | 1.20690 | „ |
| 3.94 | 1.21919 | 7.44 | 1.21571 | 10.92 | 1.21228 | 16.45 | 1.20681 | „ |
| 4.44 | 1.21869 | 7.94 | 1.21522 | 11.43 | 1.21178 | 17.45 | 1.20582 | „ |
| 4.75 | 1.21840 | 8.44 | 1.21472 | 12.44 | 1.21079 | 19.96 | 1.20336 | „ |
| 4.95 | 1.21819 | | | | | | | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | |
|---|---|---|
| 15 | 2165 | B.E. (1935) |
| 30 | 1634 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 43.95 | B.E. (1935) |
| 20 | 43.35 | „ |
| 30 | 42.17 | „ |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.54683 | 1.54785 | — | 1.55483 | 1.56947 | 1.57325 | 1.58566 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00046 | 46 | — | 46 | 47 | 48 | 49 | „ |
| 20 | — | 1.5455 | 1.5524 | — | — | 1.5713 | — | Cotton and Mouton (1910) |
| 20 | — | — | 1.55230 | — | — | — | — | Dummer (1919) |
| 20 | — | 1.54582 | — | — | — | — | — | Brand and kranz (1927) |
| 25 | — | — | 1.55006 | — | — | — | — | Harris (1925) |
| 25 | — | 1.54348 | — | — | — | — | — | Martin and George (1933) |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 10 | 37.85 | Ball (1930) | 54 | 29.99 | Ball (1930) |
| 12.8 | 37.30 | „ | 60 | 29.08 | „ |
| 18 | 36.23 | „ | 80 | 26.28 | „ |
| 25 | 34.89 | „ | 25 | 34.890 | Le Fevre and Le Fevre (1936) |
| 30 | 33.97 | „ | | | |
| 32.9 | 33.48 | „ | 20 | 35.965 | Mouradoff (unp.) |
| 40 | 32.26 | „ | | | |

*Magnetic rotatory power*

| t° | (μ) | |
|---|---|---|
| 15 | 1.6566 | Perkin (1896) |
| 19 | 1.6515 | „ |
| 56 | 1.6149 | „ |

**Heat constants**

| | | |
|---|---|---|
| *Heat of melting* | 22.50 cal 15°/g | Meyer (1910) |

DINITROBENZENES: $C_6H_4(NO_2)_2$:

*Ortho: Melting point:* Johnston and Jones (1928).

*Ortho, meta* and *para: Melting point, specific heat* and *heat of melting:* Andrews, Lynn and Johnston (1926).

*Meta: Melting point:* Reissert (1890); Desvergnes (1925) and Skau (1930–1935); *Melting point* and *heat of combustion:* Garner and Abernetty (1921); Badoche (1939); Robertson (1902) and Rinkenbach (1930).

## *o*-NITROTOLUENE

$C_6H_4\begin{cases}CH_3\ (1)\\NO_2\ (2)\end{cases}$

### Constants

*Saturated vapour pressure:* KAHLBAUM (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 81.8 | 5 | 100.2 | 13 | 108.4 | 19 | 114.8 | 25 |
| 85.2 | 6 | 101.7 | 14 | 109.6 | 20 | 115.7 | 26 |
| 90.6 | 8 | 103.2 | 15 | 110.7 | 21 | 117.5 | 28 |
| 92.9 | 9 | 104.6 | 16 | 111.8 | 22 | 118.4 | 29 |
| 94.8 | 10 | 105.8 | 17 | 112.8 | 23 | 119.2 | 30 |
| 96.8 | 11 | 107.2 | 18 | 113.8 | 24 | 120.0 | 31 |
| 98.6 | 12 | | | | | | |

*Boiling point*

| | | | |
|---|---|---|---|
| 221°7 | DE BEULE (1933) | 221°75 | LECAT (passim) |

*Melting point*

| | | |
|---|---|---|
| $\beta$ −3°17 | (*stable* form) | DE BEULE (1933) and DEFFET (1935) |
| $\alpha$ −9°27 | (*unstable* form) | ,, |

*Melting curve:* DEFFET (1935)

| *Stable form β* | | | | *Unstable form α* | | | |
|---|---|---|---|---|---|---|---|
| t° | p kg cm² | t° | p kg/cm² | t° | p kg cm² | t° | p kg cm² |
| −3.17 | 1 | +10.00 | 640 | −9.27 | 1 | +5.00 | 716 |
| −0.4 | 136 | 15.50 | 912 | −5.0 | 198 | 10.00 | 978 |
| | | | | −0.1 | 452 | | |

*Critical solution point in isopentane:* 8·65 HENNAUT-ROLAND (1933)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.18229 | HENNAUT-ROLAND (1933) | 0 | 1.1820 | BINGHAM and GEDDES |
| 15 | 1.16781 | ,, | 10 | 1.1723 | ,, (1934) |
| 30 | 1.15321 | ,, | 20 | 1.1626 | ,, |
| 20 | 1.1629 | BRÜHL (1895) | 30 | 1.1531 | ,, |
| 20.4 | 1.1625 | ,, | 40 | 1.1435 | |
| | | | 60 | 1.1236 | |
| | | | 80 | 1.1041 | |
| | | | 100 | 1.0842 | |

*Viscosity*

| t° | $\eta \cdot 10^4$ | | t° | $\eta \cdot 10^4$ | |
|---|---|---|---|---|---|
| 15 | 262.2 | HENNAUT-ROLAND (1933) | 30 | 194 | BINGHAM and GEDDES |
| 30 | 191.1 | „ | 40 | 163 | „ (1934) |
| 0 | 383 | BINGHAM and GEDDES | 60 | 121 | „ |
| 10 | 296 | „ (1934) | 80 | 94 | „ |
| 20 | 237 | „ | 100 | 76 | „ |

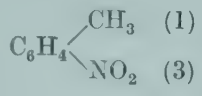
*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 15 | 42.29 | HENNAUT-ROLAND (1933) | 19.5 | 41.76 | SUGDEN and WILKINS (1925) |
| 20 | 41.67 | „ | | | |
| 30 | 40.50 | „ | | | |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|
| 15 | 1.54144 | 1.54231 | 1.54884 | 1.56220 | 1.56570 | 1.57732 | HENNAUT-ROLAND (1933) |
| $\frac{dn}{dt}$ | 0.00046 | 46 | 47 | 48 | 49 | 50 | „ |

## *m*-NITROTOLUENE



**Constants:** HENNAUT-ROLAND (1933)

| *Boiling point* | | *Melting point* | |
|---|---|---|---|
| 232°6 | DE BEULE (1933) | 16°05 | DEFFET (1935) |
| | | 16°1 | SCHEUER (1910) |
| | | 16°10 | DE BEULE (1933) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|---|---|
| 16.05 | 1 | 25.00 | 372 | 35.00 | 781 |
| 20.00 | 164 | 30.00 | 578 | 40.00 | 982 |

*Critical solution point in isopentane:* 7°05

*Density*

| t° | d |
|---|---|
| 15 | 1.16176 |
| 20 | 1.15712 |
| 30 | 1.14766 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 2563 |
| 30 | 1777 |

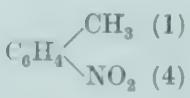
*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 41.73 |
| 30 | 39.91 |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.54144 | 1.54229 | 1.54918 | 1.56296 | 1.56673 | 1.57856 |
| $\frac{dn}{dt}$ | 0.00045 | 44 | 46 | 46 | 49 | 49 |

## *p*-NITROTOLUENE




**Constants:** B.E. (1937)

*Saturated vapour pressure:* KAHLBAUM (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 92.3 | 5 | 107.5 | 11 | 112.4 | 14 | 116.6 | 17 |
| 95.7 | 6 | 109.3 | 12 | 113.9 | 15 | 117.8 | 18 |
| 101.2 | 8 | 110.9 | 13 | 115.3 | 16 | 119.1 | 19 |
| 105.6 | 10 | | | | | | |

*Boiling point*

| | |
|---|---|
| 238°34 | BERLINER and MAY (1926) |
| 238°4 | DE BEULE (1933) |
| 238°5 | $\frac{dt}{dp}$ *(10 mm)*: 0°54 B.E. (1937) |
| 238°9 | LECAT |
| 238°9 | NEUBECK (1887) |

*Melting point*

| | |
|---|---|
| 51°6 | BERLINER and MAY (1926) |
| 51°6 | DE BEULE (1933) |
| 51°65 | B.E. (1937) and DEFFET (1935) |
| 52°06 | DESVERGNES (1925) |
| 52°1 | GARNER and ABERNETTY (1921) |

*Melting curve:* DEFFET (1935)

| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|---|---|
| 51.65 | 1 | 65.00 | 483 | 74.95 | 857 |
| 55.00 | 112 | 70.00 | 671 | 77.95 | 972 |
| 60.00 | 297 | | | | |

*Density*

| t° | d | t° | d | |
|---|---|---|---|---|
| 55 | 1.12259 | 70 | 1.10857 | B.E. (1937) |
| 60 | 1.11788 | 75 | 1.10392 | |
| 65 | 1.11324 | | | |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 60 | 1204 |
| 75 | 980 |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 60 | 36.83 | |
| 70 | 35.64 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. |
|---|---|---|---|---|---|
| 15 | 1.53019 | 1.53123 | 1.53818 | 1.53844 | 1.55347 |
| $\frac{dn}{dt}$ | 0.00044 | 44 | — | 44 | 45 |

## 2,4,6-TRINITROTOLUENE $C_6H_2(CH_3)(NO_2)_3$ (2,4,6)

*Melting point:* 80° 1

*Velocity of crystallization:* Campbell and Pritchard (1947)

| t° | mm/min. | t° | mm/min. | |
|---|---|---|---|---|
| 30.0 | 171 | 60.0 | 94 | |
| 40.0 | 158 | 70.0 | 35 | |
| 50.0 | 126 | | | |

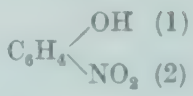
PICRATES of PRIMARY, SECONDARY and TERTIARY AMINES and of QUATERNARY AMMONIUM BASES: $C_6H_2.(NO_2)_3.ONH_3R$ (R = alkyl), $ONH_2(R)_2$, $ONH(R)_3$, $ON(R)_4$: *Melting point, viscosity* and *conductivity:* Walden, Ulich and Birr (1928).

*p*-NITROSOMETHYLANILINE (Phenylmethylnitrosamine) $C_6H_5N(NO)CH_3$: *Density* and *refractive index:* Cowley and Partington (1933) and *density* and *surface tension:* Turner and Merry (1910).

α-NITRONAPHTHALENE: $C_{10}H_7NO_2$-α: *Melting point:* Patterson (1908); Cumming and Steel (1923); *Melting point* and *Heat of Combustion:* Rinkenbach (1930) and Badoche (1937).

1,5 and 1,8-DINITRONAPHTHALENE: $C_{10}H_6(NO_2)_2$ and 1,3,8 and 1,4,5-TRINITRONAPHTHALENE: $C_{10}H_5(NO_2)_3$: *Melting point* and *heat of combustion:* Rinkenbach (1930) and Badoche (1937).

## *o*-NITROPHENOL




### Constants

*Boiling point*

| | |
|---|---|
| 217°2 | LECAT |

*Melting point*

| | |
|---|---|
| 44°9 | SIDGWICK, SPURREEL and DAVIES (1915) |
| 44°95 | HULETT (1899) |
| 45° | EFREMOW (1919) |
| 45°1 | GARNER and ABERNETTY (1921) |

*Melting curve:* HULETT (1899)

| t° | p atm/cm² | t° | p atm/cm² | t° | p atm/cm² |
|---|---|---|---|---|---|
| 44.95 | 1 | 47.85 | 125 | 50.90 | 250 |
| 45.40 | 25 | 48.40 | 150 | 51.60 | 275 |
| 46.10 | 50 | 48.95 | 175 | 52.00 | 300 |
| 46.80 | 75 | 49.60 | 200 | | |
| 47.25 | 100 | 50.25 | 225 | | |

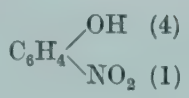
*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 30 | 1.3045 | BRAMLEY (1916) | 60 | 1.2712 | BRAMLEY (1916) |
| 40 | 1.2942 | „ | 80 | 1.2482 | „ |

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 30 | 3650 | BRAMLEY (1916) | 60.1 | 1823 | BRAMLEY (1916) |
| 40 | 2755 | „ | 80 | 1348 | „ |

## *p*-NITROPHENOL




### Constants

*Saturated vapour pressure:* CAMPBELL and CAMPBELL (1941)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 120 | 0.60 | 150.5 | 3.17 | 162 | 5.63 | 177 | 12.62 |
| 130 | 0.93 | 153 | 3.47 | 165 | 6.92 | 182 | 15.2 |
| 142 | 1.91 | 156 | 3.81 | 168 | 7.59 | 184 | 17.4 |
| 146 | 2.24 | 157 | 4.27 | 169 | 8.71 | 186 | 18.7 |
| 149 | 2.82 | | | | | | |

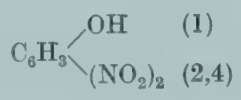
*Melting point*

| | | | |
|---|---|---|---|
| 113°8 | KENDALL (1914–16) | 114° | SWARTS (1914) |
| 113°8 | SIDGWICK, SPURRELL and DAVIES (1915) | 114° | SCHIFF (1884) |
| 114° | BELLUCCI and GRASSI (1913) | 114°1 | EFREMOW (1919) |

| | | | |
|---|---|---|---|
| *Density:* | 117°3 | 1.282 | CAMPBELL and CAMPBELL (1941) |
| *Viscosity:* $\eta \cdot 10^5$ | 121° | 2560 | ,, |
| *Surface tension* $\gamma$: | 121° | 46.3 | ,, |

| | | |
|---|---|---|
| *Heat of melting* | 41.7 cal 15°/g | CAMPBELL and CAMPBELL (1941) |

## 2,4-DINITROPHENOL




### Constants

*Melting point*

| | | | |
|---|---|---|---|
| 112°8 | GRINAKOWSKI (1913) | 113° | HOLLEMAN and WILHELMY (1902) |
| 112°8 | BOGOJAWLENSKY (1902) | 114° | KENDALL (1914) |
| 112°9 | SIDGWICK and ALDOUS (1921) | | |

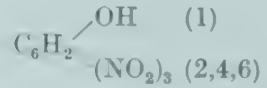
*Velocity of crystallization*

| t° | mm/min. | | t° | mm/min. | |
|---|---|---|---|---|---|
| 40 | 88.3 | Bogojawlensky (1898) | 80 | 30.3 | Bogojawlensky (1898) |
| 50 | 83.2 | „ | 90 | 16.2 | „ |
| 60 | 76.8 | „ | 100 | 6.35 | „ |
| 70 | 55.7 | „ | | | |

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 72.5 | 1.4829 | Grinakowski (1913) | 111.0 | 1.4386 | Grinakowski (1913) |
| 84.0 | 1.4664 | „ | 121.0 | 1.4281 | „ |
| 101.0 | 1.4484 | „ | 132.5 | 1.4157 | „ |

## PICRIC ACID or 2,4,6-TRINITROPHENOL

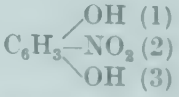



*Melting point:* 122° Bogojawlensky (1898)

*Velocity of crystallization*

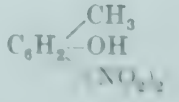
| t° | mm/min. | | t° | mm/min. | |
|---|---|---|---|---|---|
| 80 | 858 | Bogojawlensky (1898) | 95 | 783 | Bogojawlensky (1898) |
| 85 | 858 | „ | 100 | 681 | „ |
| 90 | 811 | „ | 110 | 343 | „ |

## 2-NITRORESORCINOL



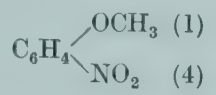

*Melting point, density* and *viscosity:* Friend and Hargreaves (1946).

## DINITRO-*o*-CRESOLS




*Saturated vapour pressure:* Balson (1947)

## *p*-NITROANISOLE



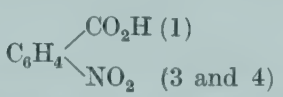
**Constants:** Puschin and Grebenschtschikow (1912)

*Melting point:* 52°5

*Melting curve*

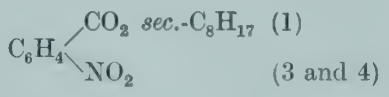
| t° | p kg/cm² | t° | p kg/cm² | t° | p kg/cm² |
|---|---|---|---|---|---|
| 52.5 | 1 | 76.1 | 1050 | 90.1 | 1750 |
| 65.0 | 550 | 80.3 | 1250 | 96.2 | 2050 |
| 69.4 | 750 | 86.2 | 1550 | 100.0 | 2250 |

## *m* and *p*-NITROBENZOIC ACIDS:



*Melting point:* Bakunin and Angrisani (1915) and *melting point, specific heat* and *heat of fusion:* Andrews, Lynn and Johnston (1926).

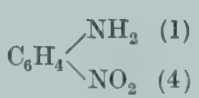
## *sec.*OCTYL *m* and *p*-NITROBENZOATES *d* and *l:*



*Density* and *rotatory power:* Rule and Numbers (1926)

METHYL *l*-α-*o*-NITROBENZOYLOXYPROPIONATE: $C_6H_4(NO_2)CO.O.CH_2.CH_2.CO_2CH_3$: *Density* and *rotatory power:* Patterson and Lawson (1929).

## *p*-NITROANILINE



**Constants**

*Melting point*

| | | | |
|---|---|---|---|
| 147° | Gross and Saylor (1931) | 147°5 | Collett and Johnston (1926) |
| 147°0 | Efremow (1927) | 147°5 | Swarts (1914) |
| 147°5 | Andrews, Lynn and Johnston (1926) | 148°3 | Holleman, Hartogs and Van der Linden (1911) |
| 147°5 | Johnston and Jones (1928) | | |

| | | |
|---|---|---|
| *Specific heat* | 147°5 L. 0.479 cal 15°/g | Andrews, Lynn and Johnston (1926) |
| | 147°5 C. 0.447 „ | „ |
| | 25° C. 0.293 „ | „ |
| *Heat of fusion* | 36.50 „ | „ |

# 12. MIXED HALOGENATED NITROGEN DERIVATIVES

## CYANOGEN CHLORIDE CNCl

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −6 | 342.1 | 1.85 | 483.6 | 9.10 | 658.3 | Douglas and Winkler |
| −5.6 | 348.3 | 3.40 | 515.4 | 10.60 | 697.3 | „ (1947) |
| −4.8 | 359.1 | 5.00 | 558.0 | 12.80 | 754.8 | „ |
| −2.8 | 396.3 | 6.20 | 581.2 | 13.00 | 763.0 | „ |
| 0.00 | 446.5 | 7.40 | 616.5 | 17.82 | 916.5 | „ |
| −12 | 233 | | | | | |
| −10 | 265 | − 2 | 408 | 8 | 621 | Klemenc and Wagner |
| − 8 | 302 | 0 | 445 | 10 | 674 | „ (1938) |
| − 6 | 341 | 2 | 484 | 12 | 730 | „ |
| − 4 | 373 | 4 | 527 | 14 | 790 | „ |
| | | 6 | 573 | | | „ |

| *Boiling point* | | *Freezing point* | |
|---|---|---|---|
| 13.0 | Klemenc and Wagner (1938) | −6.5 | Klemenc and Wagner (1938) |
| | | −6.90 | Douglas and Winkler (1947) |

*Triple point:* — 6°3/337 mm Klemenc and Wagner (1938)

## CYANOGEN IODIDE CNI

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| 25.0 | 1.2 | 51.45 | 7.1 | 70.69 | 23.6 | Jost and Stone (1933) |
| 46.15 | 4.7 | 55.42 | 8.9 | 73.34 | 28.7 | „ |
| 49.88 | 5.9 | 66.44 | 18.3 | 81.42 | 43.4 | „ |
| | | | | 100.93 | 121.7 | „ |
| 79.3 | 41.4 | 119.6 | 314.0 | 139.8 | 755.0 | Ketelaar and Kruyer |
| 89.2 | 77.7 | 122.0 | 343.1 | 142.1 | 838 | „ (1943) |
| 100.6 | 117.5 | 123.2 | 360.3 | 146.0 | 976 | |
| 105.0 | 153.0 | 124.8 | 400.9 | 148.0 | 1040 | |
| 108.8 | 186.2 | 128.2 | 466.9 | 149.6 | 1085 | |
| 113.1 | 238.5 | 133.9 | 605.6 | 151.6 | 1153 | |

*Triple point:* 146°/993 mm KETELAAR and KRUYER (1943)

| | | |
|---|---|---|
| *Heat of sublimation* | 93.58 cal 15°/g | KETELAAR and KRUYER (1943) |
| *Heat of vaporization* | 62.52 „ | „ |
| *Heat of melting* | 31.06 „ | „ |

## α-CHLORO-NITRILES

**Constants:** VANDEWYER (1935)

| | *Density* | | *Refractive index* | | | | |
|---|---|---|---|---|---|---|---|
| | 15° | 30° | t° | Hα | D | Hβ | Hγ |
| $CH_2Cl—CN$ | 1.20269 | 1.18322 | 15 | 1.42326 | 1.42562 | 1.43140 | 1.43575 |
| | | | 30 | 1.41685 | 1.41905 | 1.42459 | 1.42913 |
| $CH_3—CHCl—CN$ | 1.07398 | 1.05581 | 15 | 1.41166 | 1.41386 | 1.41918 | 1.42346 |
| | | | 30 | 1.40518 | 1.40734 | 1.41260 | 1.41700 |
| $C_2H_5—CHCl—CN$ | 1.03901 | 1.02245 | 15 | 1.42124 | 1.42348 | 1.42887 | 1.43336 |
| | | | 30 | 1.41513 | 1.41725 | 1.42263 | 1.42703 |
| $C_3H_7—CHCl—CN$ | 1.00777 | 0.99241 | 15 | 1.42649 | 1.42864 | 1.43412 | 1.43863 |
| | | | 30 | 1.42042 | 1.42261 | 1.42805 | 1.43248 |
| $C_4H_9—CHCl—CN$ | 0.98801 | 0.97381 | 15 | 1.43217 | 1.43439 | 1.43996 | 1.44440 |
| | | | 30 | 1.42620 | 1.42841 | 1.43387 | 1.43824 |
| $C_5H_{11}—CHCl—CN$ | 0.97138 | 0.95765 | 15 | 1.43591 | 1.43819 | 1.44384 | 1.44843 |
| | | | 30 | 1.43016 | 1.43240 | 1.43787 | 1.44230 |
| $C_6H_{13}—CHCl—CN$ | 0.95889 | 0.94559 | 15 | 1.43900 | 1.44136 | 1.44693 | 1.45154 |
| | | | 30 | 1.43359 | 1.43583 | 1.44145 | 1.44594 |
| $C_7H_{15}—CHCl—CN$ | 0.94868 | 0.93602 | 15 | 1.44179 | 1.44412 | 1.44975 | 1.45434 |
| | | | 30 | 1.43663 | 1.43878 | 1.44445 | 1.44882 |
| $C_8H_{17}—CHCl—CN$ | 0.94068 | 0.92834 | 15 | 1.44444 | 1.44673 | 1.45234 | 1.45691 |
| | | | 30 | 1.43924 | 1.44146 | 1.44704 | 1.45136 |
| $C_9H_{19}—CHCl—CN$ | 0.93345 | 0.92151 | 15 | 1.44635 | 1.44866 | 1.45445 | 1.45901 |
| | | | 30 | 1.44133 | 1.44354 | 1.44917 | 1.45369 |

γ-CHLOROBUTYRO-, β-CHLORO *iso*-BUTYRO-, γ-CHLOROCROTO- and β-CHLORO-α-METHYLACRYLONITRILES: $CH_2Cl—CH_2—CH_2—CN$, $CH_2Cl—CH(CH_3)—CN$, $CH_2Cl—CH=CH—CN$, $CHCl=C(CH_3)—CN$: *Boiling point, density* and *refractive index:* BERTHET (1941).

α-ETHYL-β-CHLOROBUTYRONITRILE: $CH_3—CHCl—CH(C_2H_5)—CN$: *Boiling point, density* and *refractive index:* BRUYLANTS and ERNOULD (1932).

α-BROMOCROTONITRILES: $CH_3—CH=CBr—CN$: *Boiling* and *melting points, density* and *refractive index:* LECLERQ and BRUYLANTS (1949)

BROMOBENZYLCYANIDE: $C_6H_4Br—CH_2—CN$: *Saturated vapour pressure*: Balson (1947)

α-BROMOCROTONAMIDES: $CH_3—CH=CBr—CONH_2$: *Melting point*: Leclerq and Bruylants (1949)

CHLOROPICRIN: $CCl_3NO_2$: *Saturated vapour pressure*: Oyaiza (1927) and Blaszkowska-Zakrzewska (1928). Their values do not agree.

*d*-GLUTAMIC ACID HYDROCHLORIDE: $CO_2H.CH_2.CH_2.CH.(NH_2).CO_2H.HCl$ and ORNITHINE DIHYDROCHLORIDE: $NH_2CH_2.(CH_2)_2.CH(NH_2).CO_2H.2HCl$: *Specific heat:* Huffman, Ellis and Borsook (1940)

## METHYLAMMONIUM CHLORIDE $CH_3NH_3Cl$

**Constants**: Aston and Ziemer (1946) (M.W. 67.523)

*Specific heat:*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|
| γ Form | | | | | |
| L. −249.78 | 0.03230 | −161.75 | 0.21261 | −70.74 | 0.27836 |
| −238.41 | 0.06521 | −149.20 | 0.22428 | −60.46 | 0.28393 |
| −227.89 | 0.09724 | −135.00 | 0.23629 | −50.70 | 0.29029 |
| −210.07 | 0.1397 | −126.72 | 0.24264 | −37.27 | 0.29615 |
| −201.45 | 0.15750 | −111.37 | 0.25311 | −30.91 | 0.3000 |
| −187.23 | 0.18167 | −102.77 | 0.26031 | −20.37 | 0.3048 |
| −180.93 | 0.19067 | − 90.56 | 0.26736 | −13.32 | 0.3080 |
| −170.95 | 0.20349 | − 77.03 | 0.27527 | − 1.09 | 0.3344 |
| β Form | | | | | |
| L. −260.06 | 0.00372 | −190.80 | 0.16104 | −119.32 | 0.24082 |
| −249.18 | 0.02275 | −178.42 | 0.18083 | −110.20 | 0.24806 |
| −241.88 | 0.04138 | −172.08 | 0.18956 | −103.50 | 0.25333 |
| −228.91 | 0.07698 | −161.42 | 0.20172 | −89.75 | 0.26326 |
| −218.94 | 0.1022 | −148.67 | 0.21433 | −76.67 | 0.27191 |
| −210.96 | 0.1210 | −138.10 | 0.22472 | −65.94 | 0.27976 |
| −203.16 | 0.1371 | −131.66 | 0.23118 | −59.83 | 0.28484 |
| α Form | | | | | |
| L. −45.96 | 0.3033 | −7.39 | 0.3089 | 12.80 | 0.3162 |
| −40.11 | 0.3021 | −7.19 | 0.3091 | 13.16 | 0.3166 |
| −33.61 | 0.3028 | −0.93 | 0.3120 | 16.63 | 0.3191 |
| −27.09 | 0.3040 | +5.70 | 0.3143 | 18.94 | 0.3199 |
| −20.10 | 0.3051 | 5.89 | 0.3154 | 20.55 | 0.3203 |
| −14.10 | 0.3070 | 6.13 | 0.3154 | 24.81 | 0.3254 |

*Heats of transition*

*Lower:* −52°76 6.297 cal 15°/g

*Higher:* − 8°66 9.976 cal 15°/g

## TETRAMETHYLAMMONIUM IODIDE $(CH_3)_4\,NI$

*Specific heat:* Coulter, Pitzer and Latimer (1940) (M.W. 201.03)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −259.06 | 0.008526 | −182.34 | 0.08974 | −106.21 | 0.1323 | −28.41 | 0.1700 |
| −249.33 | 0.02555 | −173.90 | 0.09501 | − 87.82 | 0.1413 | −19.79 | 0.1711 |
| −238.99 | 0.04222 | −165.50 | 0.1001 | − 77.84 | 0.1462 | −10.98 | 0.1768 |
| −231.45 | 0.05278 | −156.66 | 0.1053 | − 67.89 | 0.1507 | 8.93 | 0.1865 |
| −218.34 | 0.06521 | −147.33 | 0.1106 | − 58.63 | 0.1547 | 16.83 | 0.1880 |
| −209.30 | 0.07272 | −140.62 | 0.1146 | − 48.88 | 0.1592 | 24.37 | 0.1917 |
| −198.06 | 0.07939 | −123.56 | 0.1229 | − 38.63 | 0.1631 | | |
| −190.39 | 0.08461 | | | | | | |

## ANILINE HYDROCHLORIDE $C_6H_5\,NH_2.HCl$

**Constants:** Leopold (1910)

*Saturated vapour pressure*

| t° | p mm | t° | p mm |
|---|---|---|---|
| S. + G. 113 | 3 | S. + L. + G. 198 | 162 |
| 137 | 9 | 199.2 | 222 |
| 156 | 23 | L. + G. 202 | 248 |
| 180 | 73 | 205 | 273 |
| 197.5 | 158 | 207 | 297 |

## FLUOROANILINES $C_6H_4FNH_2$

**Constants:** Swarts (1913–19–23–31)

| *Ortho* | *Meta* | *Para* |
|---|---|---|
| *Boiling point* | | |
| — | 186°4 Swarts (1913)<br>186°3 „ (1919) | 187°4 Swarts (1913–19) |
| *Melting point* | | |
| — | — | 0°82 Swarts (1919) |
| *Density* | | |
| 10° 1.1437 Schiemann (1931) | 15°8 1.16015 Swarts (1913–23)<br>15°8 1.16004 Swarts (1919) | 16°9 1.1613 Swarts (1913)<br>25°2 1.15236 Swarts (1919–23) |

(continued)

| *Ortho* | | | *Meta* | | | *Para* | | |
|---|---|---|---|---|---|---|---|---|
| *Viscosity* | | | | | | | | |
| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
| 20.27 | 2565 | SWARTS (1931) | 25 | 2175 | SWARTS (1931) | 20 | 3025 | SWARTS (1931) |
| 30.05 | 2090 | „ | 30 | 2200 | „ | 30 | 2370 | „ |
| 40 | 1700 | „ | 40 | 1750 | „ | 40.05 | 1925 | „ |
| 50 | 1405 | „ | 50 | 1480 | „ | 50.03 | 1580 | „ |
| 60 | 1198 | „ | 60 | 1250 | „ | 60 | 1340 | „ |
| *Refractive index* | | | | | | | | |
| | 18° | | | 15°8 | 25°2 | | 18°5 | 20° |
| Hα | 1.54118 | | | 1.5414 | 1.53000 | | 1.53975 | 1.53618 |
| D | 1.54672 | | | 1.54737 | — | | 1.54528 | 1.53945 |
| Hβ | 1.56263 | | | 1.56157 | 1.55155 | | 1.56132 | 1.56078 |
| Hγ | 1.57174 | | | 1.57710 | 1.56530 | | 1.57520 | 1.57344 |
| | SCHIEMANN (1931) | | | SWARTS (1923) | | | SCHIEMANN (1931) | |

## 2,5-DIFLUOROANILINE $C_6H_3F_2NH_2$

**Constants:** SWARTS (1914–23–31)

*Freezing point:* 13°45

*Density:* 18°1 1.2880

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ |
|---|---|---|---|
| 20 | 2320 | 50 | 1325 |
| 30 | 1875 | 59.95 | 1135 |
| 40 | 1564 | | |

*Refractive index*

| t° | Hα | D | Hβ | Hγ |
|---|---|---|---|---|
| 18.1 | 1.5007 | 1.5045 | 1.5296 | 1.5424 |

## *o*-CHLOROANILINE $o\text{-}C_6H_4\,Cl\,NH_2$

### Constants

*Saturated vapour pressure:* KAHLBAUM (1898)

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 104.2 | 25 | 109.1 | 31 | 114.6 | 39 | 118.1 | 45 |
| 105.1 | 26 | 109.9 | 32 | 115.2 | 40 | 118.6 | 46 |
| 105.9 | 27 | 110.6 | 33 | 115.8 | 41 | 119.1 | 47 |
| 106.8 | 28 | 111.3 | 34 | 116.4 | 42 | 119.7 | 48 |
| 107.6 | 29 | 112.0 | 35 | 117.5 | 44 | | |
| 108.4 | 30 | 114.0 | 38 | | | | |

*Boiling point:* 207°0 SIDGWICK and RUBIE (1921)

BROMOANILINES: *o*, *m* and $p\text{-}C_6H_4\,Br\,NH_2$: *Boiling point* and *refractive index:* BRÜHL (1895); *Density* and *viscosity*: BINGHAM and GEDDES (1934).

## FLUORONITROBENZENES $C_6H_4\,F\,NO_2$

### Constants

*Meta*

*Boiling point*

200°37 SWARTS (1913)

*Freezing point*

| | | |
|---|---|---|
| | 3°6 | SWARTS (1913–19) |
| α | 4°1 | HASSELBLATT (1913) |
| β | 3°1 | „ |

*Density*

| | | |
|---|---|---|
| 17°2 | 1.3273 | SWARTS (1913–23) |
| 19° | 1.3254 | SCHIEMANN (1931) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 25 | 2180 | 45 | 1520 | SWARTS (1931) |
| 30.1 | 1985 | 55 | 1305 | „ |
| 35 | 1797 | 64.8 | 1148 | „ |

*Refractive index*

| | 17°2 | 19° |
|---|---|---|
| Hα | 1.52171 | 1.52007 |
| D | 1.52800 | 1.52622 |
| Hβ | 1.54490 | 1.54281 |
| Hγ | 1.56072 | 1.55889 |
| | SWARTS (1923) | SCHIEMANN (1931) |

*Para*

| | |
|---|---|
| 205° | WALLACH and HEUSSLER (1886) |
| 205° | BEEKMAN (1904) |
| 206°7 | SWARTS (1913) |

| | |
|---|---|
| 26°5 | WALLACH and HEUSSLER (1886) |
| 26°5 | BEEKMAN (1904) |
| 27° | SWARTS (1913–19) |
| 27° | VAN HOVE (1926) |

| | | |
|---|---|---|
| 20° | 1.3300 | SCHIEMANN (1931) |
| 84°48 | 1.2583 | BEEKMANN (1904) |

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 30.1 | 2245 | 60.45 | 1332 | SWARTS |
| 40.05 | 1840 | 65 | 1248 | „ (1931) |
| 50 | 1560 | | | „ |

| 20° | 56°1 |
|---|---|
| 1.52471 | 1.51004 |
| 1.53156 | 1.5150 |
| 1.54876 | 1.53252 |
| 1.56567 | 1.54880 |
| SCHIEMANN (1931) | SWARTS (1923) |

CHLORONITROBENZENES: $C_6H_4ClNO_2$. The data published for *ortho* and *para* chloronitrobenzenes are incompatible. Only *meta* chloronitrobenzene seems to have been thoroughly studied.

## *m*-CHLORONITROBENZENE $m$-$C_6H_4ClNO_2$

### Constants

*Melting point*

| | | | | | |
|---|---|---|---|---|---|
| 24°0 | *metastable* form | HASSELBLATT (1913) | 44°5 | *stable* form | JAGIELSKI (1936) |
| 44°6 | *stable* form | ,, | 44°4 | | BEEKMAN (1904) |
| 44°5 | | PUSCHIN (1926) | 44°4 | | BOGOJALENSKY and WINOGRADOW (1908) |
| 44°5 | | MENSCHUTKIN (1909) | | | |
| | | | 44°2 | | DODD and HU PAK MI (1949) |

*Melting curve*

| t° | p kg/cm² | | t° | p kg cm² | |
|---|---|---|---|---|---|
| 51.6 | 350 | PUSCHIN (1926) | 83.9 | 1750 | PUSCHIN (1926) |
| 59.1 | 650 | ,, | 90.5 | 2050 | ,, |
| 68.5 | 1050 | ,, | 96.5 | 2350 | ,, |
| 73.1 | 1250 | ,, | 98.3 | 2450 | ,, |
| 79.8 | 1550 | ,, | | | |

*Density*

| t° | d | | t | d | |
|---|---|---|---|---|---|
| 80.5 | 1.3112 | HOLLEMAN and DE BRUYN (1900) | 79.4 | 1.3112 | JAGIELSKI (1936) |
| | | | 92.9 | 1.2963 | ,, |
| 80.5 | 1.3112 | BEEKMAN (1904) | 99.4 | 1.2898 | ,, |
| 50.4 | 1.3422 | JAGIELSKI (1936) | 128.5 | 1.2582 | ,, |
| 61.6 | 1.3305 | ,, | 135.3 | 1.2508 | ,, |
| 70.5 | 1.3208 | ,, | 143.6 | 1.2413 | ,, |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|---|
| 21.1 | 3093 | 66.7 | 1478 | 107.3 | 903 | Jagielski (1937) |
| 21.9 | 3049 | 74.6 | 1323 | 112.9 | 854 | ,, |
| 29.5 | 2752 | 82.4 | 1195 | 122.3 | 780 | ,, |
| 35.6 | 2508 | 86.7 | 1135 | 129.1 | 732 | ,, |
| 42.1 | 2214 | 93.8 | 1048 | 136.5 | 689 | ,, |
| 47.4 | 2004 | 99.7 | 991 | 140.3 | 668 | ,, |
| 53.7 | 1804 | 100.4 | 972 | 145.9 | 644 | ,, |
| 59.7 | 1637 | | | | | ,, |

*Viscosity* from 25° to 60°: see diagram: Dodd and Hu Pak Mi (1949).

*m*-BROMONITROBENZENE: *m*-$C_6H_4$ Br $NO_2$: *Boiling point:* Beekman (1904) and Narbutt (1905); *density*: Brühl (1897) and Beekman (1904); *refractive index:* Brühl (1897) and Jürgens (1924); *heat of melting:* Bogojalensky and Winogradow (1908).

| | 4-CHLORO-1,2-DINITRO-BENZENE $C_6H_3$ Cl $(NO_2)_2$ | | | | 4-BROMO-1,2-DINITRO-BENZENE $C_6H_3$ Br $(NO_2)_2$ | | | |
|---|---|---|---|---|---|---|---|---|
| **Constants:** Müller (1914) | | | | | | | | |
| *Melting point* | f. I 50°<br>f. II 43°<br>f. III 27°<br>f. I 50°09 Desvergnes (1925) | | | | *Stable* f. 59°5<br>*Metast.* f. 34°8 | | | |
| *Density* | t° | d | t° | d | t° | d | t° | d |
| | 30 | 1.5001 | 60 | 1.4699 | 40 | 1.8239 | 70 | 1.7889 |
| | 40 | 1.4898 | 70 | 1.4602 | 50 | 1.8132 | 80 | 1.7590 |
| | 50 | 1.4799 | | | 60 | 1.8011 | | |
| *Surface tension* | t° | $\gamma$ | t° | $\gamma$ | t° | $\gamma$ | t° | $\gamma$ |
| | 30 | 13.786 | 60 | 12.301 | 40 | 13.276 | 70 | 11.969 |
| | 40 | 13.281 | 70 | 11.825 | 50 | 12.832 | 80 | 11.545 |
| | 50 | 12.782 | | | 60 | 12.398 | | |

*o* and *m*-NITROCHLOROACETOPHENONES: $C_6H_4(NO_2).CO.CH_2Cl$: *Saturated vapour pressure:* Balson (1947).

# 13. SULPHUR DERIVATIVES

## CARBON DISULPHIDE $CS_2$

Many authors recommend a chemical treatment in order to get rid of traces of sulphur in carbon disulphide; but in our opinion this treatment can be avoided by using a good dephlegmator.

Impurities such as $H_2S$ and S may be detected by the methyleneblue reaction down to a concentration of $5 \times 10^{-6}$ % (Gillo, 1938). This author corroborates the fact that it is easy to attain the fifth degree of purity ($\Delta t° = 0.000$). The pure samples must be kept in the dark.

**Constants:** B.E. (1928). — **Polyphasic equilibria**

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −18 | 51.9 | −3 | 110.7 | 12 | 215.4 | Stock, Henning and |
| −17 | 54.8 | −2 | 116.0 | 13 | 224.5 | „ Kuss (1921) |
| −16 | 57.8 | −1 | 121.6 | 14 | 234.0 | „ |
| −15 | 60.9 | 0 | 127.3 | 15 | 243.8 | „ |
| −14 | 64.2 | +1 | 133.3 | 16 | 254.0 | „ |
| −13 | 67.6 | 2 | 139.5 | 17 | 264.3 | „ |
| −12 | 71.2 | 3 | 145.9 | 18 | 275.0 | „ |
| −11 | 74.9 | 4 | 152.6 | 19 | 286.1 | „ |
| −10 | 78.8 | 5 | 159.5 | 20 | 297.5 | „ |
| − 9 | 82.8 | 6 | 166.7 | 21 | 309.2 | „ |
| − 8 | 87.0 | 7 | 174.0 | 22 | 321.3 | „ |
| − 7 | 91.4 | 8 | 181.8 | 23 | 333.8 | „ |
| − 6 | 95.9 | 9 | 189.8 | 24 | 346.6 | „ |
| − 5 | 100.7 | 10 | 198.1 | | | „ |
| − 4 | 105.6 | 11 | 206.6 | | | „ |
| −50 | 7 | −15 | 61 | 8 | 182 | Seelig (1920) |
| −45 | 10 | −10 | 79 | 10 | 198 | „ |
| −40 | 14 | − 5 | 100 | 12 | 215 | „ |
| −35 | 19 | 0 | 128 | 14 | 233 | „ |
| −30 | 26 | 2 | 140 | 16 | 254 | „ |
| −25 | 35 | 4 | 153 | 18 | 276 | „ |
| −20 | 46.5 | 6 | 167 | 20 | 298 | „ |
| −78.2 | 0.68 | −21.53 | 42.69 | 10.15 | 199.46 | Siemens (1913) |
| −42.60 | 11.81 | −11.12 | 74.23 | 19.66 | 294.27 | „ |
| −31.70 | 23.64 | − 0.01 | 127.00 | 46.24 | 760.0 | „ |
| −23.49 | 39.11 | 18.37 | 279.52 | 60.23 | 1172.7 | Crafts (1913) |
| − 9.57 | 81.15 | 32.35 | 472.56 | 74.20 | 1741.5 | „ |
| + 4.40 | 155.80 | 46.26 | 760 | | | „ |

*Saturated vapour pressure* (continued)

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −25.35 | 34.3 | 0 | 127.25 | | | Henning and Stock |
| − 8.30 | 85.7 | 11.54 | 211.3 | | | „ (1921) |
| 0 | 127.9 | 20 | 298.05 | 40 | 617.5 | Ramsay and Young |
| 5 | 160.0 | 25 | 361.1 | 45 | 729.5 | „ (1887) |
| 10 | 198.45 | 30 | 434.5 | 50 | 857.1 | „ |
| 15 | 244.15 | 35 | 519.65 | | | „ |
| 15.5 | 247.8 | 20.5 | 303.0 | | | Joukovsky (1934) |
| 18.0 | 274.6 | 22.8 | 331.1 | | | „ |
| 19.3 | 290.1 | 24.3 | 350.3 | | | „ |
| 29.942 | 433.6 | 51.780 | 906.1 | 74.213 | 1741.0 | Zmaczynski (1930) |
| 35.334 | 525.76 | 57.334 | 1074.6 | 79.912 | 2026.3 | „ |
| 40.780 | 633.90 | 62.925 | 1268.1 | 85.646 | 2347.4 | „ |
| 46.262 | 760.00 | 68.551 | 1489.2 | | | „ |
| 20 | 297.4 | Sameshima (1935) | | 0 | 126.4 | Rex (1906) |
| 25 | 361.1 | „ | | 10 | 197.6 | „ |
| 30 | 434.6 | „ | | | | |
| 0.32 | 128.5 | Roland (1928) | | 20 | 298 | Faust (1912) |
| 15 | 243.2 | „ | | 29.2 | 425.0 | Hirshberg (1932) |

*Boiling point*

| | | | |
|---|---|---|---|
| 46°2 | Faust (1912) | 46°25 | Grimm and Patrick (1923) |
| 46°20 | Stull (1937) | 46°26 | Crafts (1913) |
| 46°21 | Rodger and Watson (1896) | 46°262 | Zmaczynski (1930) |
| 46°23 | Mathews (1926) | 46°28 | Ramsay and Young (1887) |
| 46°24 | Siemens (1913) | 46°29 | Sameshima (1925) |
| 46°25 | B.E. (1928) and Lecat | 46°34 | Rosanoff and Easley (1909) |
| 46°25 | Tyrer (1914) | | |
| 46°25 | Gjaldbaek and Hildebrand (1949) | | |

$\frac{dt}{dp}$ *(10 mm)*: 0°42 B.E. (1928) and Lecat

*Freezing point*

| | | | |
|---|---|---|---|
| −111°51 | Stull (1937) | −111°6 | Timmermans, Van der Horst and Kamerlingh Onnes (1922) |
| −111°53 | Clusius ans Ringer (1940) | | |

**Constants of state**

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 1.29270 | B.E. (1928) | 20 | 1.2632 | Mathews (1926) |
| 15 | 1.27055 | „ | 20 | 1.2632 | Lowry (1914) |
| 30 | 1.24817 | „ | 25 | 1.25585 | Sameshima (1925) |
| 0 | 1.29272 | Timmermans (1923) | | | |

$dt = 1.29272 - 148.1 \cdot 10^{-5}t - 30.6 \cdot 10^{-8}t^2$ Timmermans (1923) (under 0°)

*Specific volume at different temperatures:* Thorpe and Rodger (1894)

*Viscosity*

| t° | $\eta \cdot 10^5$ | | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|---|
| 0 | 436 | B.E. (1928) | −13 | 514 | Faust (1912) |
| 15 | 380 | „ | −10 | 495 | „ |
| 20 | 363 | „ | 0 | 440 | „ |
| | | | 15 | 383 | „ |
| | | | 20 | 367 | „ |
| | | | 35 | 332 | „ |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 15 | 33.07 | Hennaut-Roland and Lek (1931) |
| 20 | 32.25 | |
| 30 | 30.79 | |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.62115 | 1.62222 | 1.63189 | 1.63220 | 1.65198 | 1.65670 | 1.67912 | B.E. (1928) |
| $\frac{dn}{dt}$ | 0.00077 | 77 | 78 | 78 | 80 | 81 | 82 | „ |
| 20 | — | 1.61846 | — | — | — | 1.65267 | 1.67515 | Wüllner (1868) (6°9–23°) |
| $\frac{dn}{dt}$ | — | 0.000774 | — | — | — | 819 | — | „ |
| 15 | — | — | 1.63190 | — | — | — | — | Pulfrich (1887) |
| $\frac{dn}{dt}$ | — | — | 0.00083 | — | — | — | — | „ |
| 3.5 | — | — | 1.64143 | — | — | — | — | Berghöff (1894) |
| 22.7 | — | — | 1.62522 | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00084 | — | — | — | — | „ |
| 14.6 | — | — | 1.63230 | — | — | — | — | Ketteler (1888) |
| 20.1 | — | — | 1.62803 | — | — | — | — | „ |
| 23.5 | — | — | 1.62543 | — | — | — | — | „ |
| $\frac{dn}{dt}$ | — | — | 0.00077 | — | — | — | — | „ |

*Dielectric constant*

| t° | ε | | t° | ε | |
|---|---|---|---|---|---|
| 18 | 2.652 | Kyropoulos (1927) | −20 | 2.6858 | Le Fevre (1938) |
| 20 | 2.647 | „ | −10 | 2.6721 | „ |
| 23.5 | 2.65 | Kahlenberg and Anthony (1906) | 0 | 2.6581 | „ |
| | | | 10 | 2.6438 | „ |
| | | | 20 | 2.6318 | „ |
| 20 | 2.6331 | Piette (1947) | 25 | 2.6246 | „ |
| | | | 30 | 2.6170 | „ |
| | | | 40 | 2.6030 | „ |

*Molecular magnetic rotatory power:* 20° 9.80 Lowry (1914)

**Heat constants**

*Specific heat:* Brown and Manow (1937)

| t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|
| C. −258.11 | 0.0217 | L. −103.65 | 0.2364 |
| −209.69 | 0.1172 | −67.88 | 0.2365 |
| −169.16 | 0.1492 | −11.50 | 0.2381 |
| −122.69 | 0.1742 | +24.27 | 0.2387 |
| (other temperatures, see authors) | | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 83.8 cal 15°/g | Grimm and Patrick (1923) |
| | (46°29) 84.07 „ | Mathews (1926) |
| *Heat of melting* | 13.802 „ | Brown and Manow (1937) |

CARBON SESQUISULPHIDE: $C_2S_3$: *Melting point* and *saturated vapour pressure:* Stock and Praetorius (1912).

## METHYL MERCAPTAN $CH_3SH$

**Constants:** Russell, Osborne and Yost (1942)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| −51.280 | 41.13 | −9.474 | 399.30 | 5.977 | 760.64 |
| −23.872 | 201.46 | +0.029 | 599.40 | | |

*Boiling point:* 5°96

*Melting point:* −121°0 Timmermans

−123°00

*Transition point:* −135°56

*Specific heat*

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C.I −258.19 | 0.0161 | −235.17 | 0.1019 | −184.32 | 0.2285 | L. −117.54 | 0.4422 |
| −257.34 | 0.0184 | −233.55 | 0.1113 | −179.90 | 0.2355 | −112.66 | 0.4401 |
| −256.69 | 0.0204 | −232.43 | 0.1155 | −179.04 | 0.2366 | −111.09 | 0.4391 |
| −255.68 | 0.02341 | −229.55 | 0.1255 | −173.78 | 0.2441 | −106.36 | 0.4380 |
| −255.18 | 0.02549 | −228.76 | 0.1283 | −168.29 | 0.2515 | − 98.69 | 0.4359 |
| −253.81 | 0.02983 | −225.08 | 0.1406 | −162.79 | 0.2592 | − 89.05 | 0.4339 |
| −253.67 | 0.03068 | −224.86 | 0.1413 | −157.46 | 0.2663 | − 78.85 | 0.4324 |
| −251.99 | 0.03686 | −220.52 | 0.1546 | −155.96 | 0.2680 | − 68.65 | 0.4314 |
| −251.66 | 0.03815 | −220.12 | 0.1556 | −152.29 | 0.2734 | − 58.53 | 0.4305 |
| −249.90 | 0.04507 | −216.44 | 0.1652 | −150.87 | 0.2750 | − 48.48 | 0.4303 |
| −249.22 | 0.04781 | −215.70 | 0.1671 | −147.26 | 0.2798 | − 38.53 | 0.4310 |
| −247.53 | 0.05490 | −211.30 | 0.1777 | −145.10 | 0.2829 | − 28.68 | 0.4326 |
| −246.59 | 0.05885 | −210.63 | 0.1793 | −142.35 | 0.2869 | − 18.93 | 0.4341 |
| −244.99 | 0.06559 | −206.16 | 0.1893 | −140.13 | 0.2900 | − 9.27 | 0.4366 |
| −243.79 | 0.07069 | −201.01 | 0.1996 | −139.95 | 0.2904 | − 2.10 | 0.4393 |
| −242.19 | 0.07731 | −195.82 | 0.2098 | C.II −139.94 | 0.2902 | | |
| −240.65 | 0.08361 | −190.58 | 0.2185 | −132.74 | 0.3091 | | |
| −239.30 | 0.08908 | −185.27 | 0.2272 | −126.59 | 0.3632 | | |
| −237.20 | 0.09750 | | | | | | |

| | | |
|---|---|---|
| *Heat of vaporisation* | (B.P.) 122.10 cal 15°/g | |
| *Heat of melting* | 29.348 „ | |
| *Heat of transition* | 1.09 „ | |

## ETHYL MERCAPTAN $C_2H_5SH$

**Constants:** Berthoud and Brum (1924)

*Critical constants*

| t° cr. | d cr. | |
|---|---|---|
| 225.5 | 0.2996 | |

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 0 | 0.8623 | 0.0006 | 154.8 | 0.6456 | 0.0402 |
| 11.5 | 0.8500 | 0.0011 | 164.5 | 0.6234 | 0.0494 |
| 32.8 | 0.8240 | 0.0025 | 179.6 | 0.5913 | 0.0633 |
| 77.6 | 0.7660 | 0.0072 | 190.4 | 0.5617 | 0.0801 |
| 99.7 | 0.7342 | 0.0118 | 200.5 | 0.5322 | 0.0962 |
| 118.6 | 0.7070 | 0.0185 | 210.1 | 0.4986 | 0.1180 |
| 128.0 | 0.6947 | 0.0211 | 216.2 | 0.4691 | 0.1404 |
| 139.8 | 0.6729 | 0.0297 | 218.3 | 0.4544 | 0.1501 |

*Saturated vapour pressure*

| t° | p mm | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|
| 0 | 190 | 70 | 3.0 | 150 | 17.4 |
| 10 | 294 | 80 | 3.9 | 160 | 20.6 |
| 20 | 442 | 100 | 6.3 | 170 | 25.5 |
| 30 | 646 | 110 | 7.9 | 180 | 28.5 |
| 40 | 915 | 120 | 9.8 | 190 | 33.1 |
| 50 | 1267 | 130 | 12.0 | 200 | 35.8 |
| 60 | 1718 | 140 | 14.5 | 210 | 44.1 |
| | | | | 220 | 50.4 |

*Boiling point:* 35°05 Hunter and Partington (1931)

*Freezing point:* −147°0 Timmermans

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 0 | 0.8623 | Berthoud and Brum | 38.7 | 0.8162 | Berthoud and Brum |
| 15.4 | 0.8454 | „ (1924) | 48.4 | 0.8043 | „ (1924) |
| 23.7 | 0.8357 | „ | 78.4 | 0.7652 | „ |
| 31.7 | 0.8259 | „ | 20 | 0.8398 | Hunter and Partington (1931) |

*Surface tension*

| t° | γ | |
|---|---|---|
| 11.5 | 25.59 | Berthoud and Brum (1924) |
| 32.8 | 22.52 | „ |
| 77.6 | 16.32 | „ |

*Refractive index*

| t° | Hα | D | Hβ | Hγ | |
|---|---|---|---|---|---|
| 19.8 | 1.42844 | 1.43146 | 1.43858 | 1.44469 | Van Tussenbroek (1929) |
| 20 | — | 1.43119 | — | — | Hunter and Partington (1931) |

## DIMETHYL SULPHIDE $(CH_3)_2 S$

**Constants:** Berthoud and Brum (1924)

*Densities of the liquid and the saturated vapour*

| t° | L. | V. | t° | L. | V. |
|---|---|---|---|---|---|
| 98.9 | 0.7490 | 0.0102 | 180.8 | 0.6081 | 0.0616 |
| 119.8 | 0.7210 | 0.0173 | 183.6 | 0.6011 | 0.0661 |
| 129.8 | 0.7066 | 0.0206 | 192.2 | 0.5796 | 0.0783 |
| 139.7 | 0.6897 | 0.0267 | 199.7 | 0.5601 | 0.0908 |
| 148.1 | 0.6758 | 0.0301 | 205.8 | 0.5403 | 0.1041 |
| 154.4 | 0.6641 | 0.0359 | 210.5 | 0.5251 | 0.1146 |
| 162.3 | 0.6484 | 0.0417 | 216.1 | 0.5037 | 0.1320 |
| 172.0 | 0.6266 | 0.0529 | 220.7 | 0.4833 | 0.1474 |

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| −22.557 | 52.46 | 4.933 | 210.33 | 14.872 | 326.37 | Osborne, Doescher and Yost (1942) |
| −10.038 | 102.75 | 9.847 | 260.85 | 20.077 | 398.84 | „ |
| + 0.086 | 168.29 | | | | | |

*Boiling point*

| | |
|---|---|
| 37°2 | Strecker and Spitaler (1926) |
| 37°33 | Osborne, Doescher and Yost (1942) |
| 37°4 | Lecat |

*Melting point*

| | |
|---|---|
| −98°305 | Osborne, Doescher and Yost (1942) |

*Density*

| t° | d | t° | d | t° | d |
|---|---|---|---|---|---|
| 0 | 0.8720 | 43.3 | 0.8211 | 58.8 | 0.8023 |
| 15.8 | 0.8547 | 51.7 | 0.8108 | 60.0 | 0.8017 |
| 32.0 | 0.8347 | | | | |

*Surface tension*

| t° | $\gamma$ | |
|---|---|---|
| 11.1 | 26.50 | Berthoud and Brum (1924) |
| 32.9 | 23.33 | „ |
| 57.7 | 19.87 | „ |

*Specific heat:* Osborne, Doescher and Yost (1942) (M.W. 62.13)

| t° | cp | t° | cp | t° | cp | t° | cp |
|---|---|---|---|---|---|---|---|
| C. −259.08 | 0.0142 | −228.19 | 0.1084 | −165.30 | 0.2345 | L. −91.95 | 0.4330 |
| −257.42 | 0.01811 | −223.49 | 0.1216 | −159.45 | 0.2425 | −91.86 | 0.4328 |
| −255.61 | 0.02302 | −218.39 | 0.1349 | −153.79 | 0.2499 | −85.22 | 0.4325 |
| −253.87 | 0.02805 | −213.05 | 0.1472 | −148.31 | 0.2572 | −82.73 | 0.4320 |
| −252.08 | 0.03378 | −207.78 | 0.1596 | −142.62 | 0.2648 | −73.03 | 0.4320 |
| −250.26 | 0.03951 | −202.48 | 0.1708 | −136.88 | 0.2720 | −63.42 | 0.4324 |
| −248.29 | 0.04592 | −197.09 | 0.1822 | −131.17 | 0.2794 | −53.88 | 0.4328 |
| −245.72 | 0.05410 | −191.30 | 0.1930 | −125.14 | 0.2870 | −44.42 | 0.4341 |
| −242.83 | 0.06393 | −185.15 | 0.2036 | −119.13 | 0.2952 | −35.04 | 0.4355 |
| −239.50 | 0.07468 | −179.00 | 0.2139 | −113.16 | 0.3026 | −25.75 | 0.4375 |
| −235.96 | 0.08558 | −176.35 | 0.2179 | | | −16.10 | 0.4400 |
| −232.26 | 0.09665 | −170.94 | 0.2258 | | | − 6.10 | 0.4429 |
| | | | | | | + 3.78 | 0.4462 |
| | | | | | | 13.53 | 0.4499 |

| | | |
|---|---|---|
| *Heat of vaporisation* | (17°90 and 365.5 mm) 107.7 cal 15°/g | Osborne, Doescher and Yost (1942) |
| *Heat of melting* | 30.73 „ | „ |

## DIETHYL SULPHIDE $(C_2H_5)_2S$

**Constants:** B.E. (1935)

*Boiling point*

| | | |
|---|---|---|
| 92°10 | $\frac{dt}{dp}$ *(10 mm):* 0°40 | B.E. (1935) and Lecat |
| 92°1 | | Beckmann (1878) |

*Freezing point:* — 103°3

*Density*

| t° | d |
|---|---|
| 0 | 0.85599 |
| 15 | 0.84102 |
| 30 | 0.82607 |

*Viscosity*

| t° | $\eta \cdot 10^5$ |
|---|---|
| 15 | 467 |
| 30 | 396 |

*Surface tension*

| t° | $\gamma$ |
|---|---|
| 15 | 25.78 |
| 20 | 25.28 |
| 30 | 24.16 |

*Refractive index*

| t° | He r. | Hα | D | He y. | He g. | Hβ | He v. | |
|---|---|---|---|---|---|---|---|---|
| 15 | 1.44208 | 1.44253 | 1.44550 | 1.44567 | 1.45118 | 1.45255 | 1.45699 | B.E. (1935) |
| $\frac{dn}{dt}$ | 0.00051 | 51 | — | 51 | 51 | 51 | 52 | „ |

*Dielectric constant:* 20° 6.004 Timmermans (unp.)

Vogel and Cowan (1943) give values for dimethyl and diethyl sulphides, which do not agree with those of the preceding authors; they have also studied a series of other sulphides.

## TETRAMETHYL ORTHOTHIOCARBONATE $C(SCH_3)_4$

**Constants:** Backer and Perdok (1943)

*Melting point:* Form I 65·5 *Transition points:* Form III 23·2 Form II 45·5

*Surface tension:* 70° $\gamma$: 36

*Refractive index*

| t° | Hα | D | Hβ | Hγ |
|---|---|---|---|---|
| L. 70 | 1.5804 | 1.5853 | 1.5978 | 1.6085 |

| | |
|---|---|
| *Heat of melting* | 4.942 cal 15°/g |
| *Heat of transition* | Form III → II 7.288 ,, |
| | Form II → I 9.085 ,, |

## ALLYL *iso*-THIOCYANATE $CH_2=CH.CH_2.N=C=S$

**Constants:** B.E. (1932)

*Boiling point* — *Freezing point*

| | | | |
|---|---|---|---|
| 152°0 | $\frac{dt}{dp}$ *(10 mm)*: 0°50 | −102°5 | Timmermans |
| 152°05 | ,, 0°50 Lecat | | |

*Density* — *Viscosity*

| t° | d | t° | $\eta \cdot 10^5$ |
|---|---|---|---|
| 0 | 1.03909 | 15 | 782 |
| 15 | 1.02356 | 30 | 642 |
| 30 | 1.00811 | | |

*Surface tension*

| t° | $\gamma$ | t° | $\gamma$ | |
|---|---|---|---|---|
| 15 | 35.30 | 30 | 33.44 | |
| 20 | 34.66 | 11.5 | 35.82 | Schiff (1883) |

*Refractive index*

| t° | He r. | Hα | He y. | He g. | Hβ | He v. |
|---|---|---|---|---|---|---|
| 15 | 1.52731 | 1.52814 | 1.53349 | 1.54382 | 1.54645 | 1.55430 |
| $\frac{dn}{dt}$ | 0.00053 | 53 | 53 | 54 | 55 | 55 |

## MUSTARD GAS or YPERITE or ββ′-DICHLORODIETHYL SULPHIDE $(CH_2Cl.CH_2)_2S$

### Constants

*Saturated vapour pressure*

| *Dynam. method* | | | | *Stat. method* | | | | |
|---|---|---|---|---|---|---|---|---|
| t° | p mm | t° | p mm | t° | p mm | t° | p mm | |
| 14.9 | 0.046 | 41.8 | 0.392 | 17.8 | 0.057 | 63.2 | 1.64 | Balson, Denbigh and Adam |
| 19.7 | 0.070 | 47.6 | 0.611 | 25.0 | 0.100 | 65.3 | 2.07 | ,, (1947) |
| 25.0 | 0.106 | 68.4 | 2.26 | 31.9 | 0.188 | 71.8 | 2.97 | ,, |
| 30.1 | 0.163 | 75.8 | 3.52 | 40.0 | 0.350 | 74.3 | 3.39 | ,, |
| 35.2 | 0.239 | | | 54.8 | 1.07 | 81.7 | 5.12 | ,, |
| | | | | | | | | ,, |

| t° | p mm | |
|---|---|---|
| 30 | 0.1575 | Bent and Francel (1948) |
| 40 | 0.3363 | ,, |
| 50 | 0.6822 | ,, |

*Melting point:* 14°35 Balson, Denbigh and Adam (1947)
14°45 Felsing, Hunting and Fell (1948)

*Refractive index:* $n_D^{30°}$ 1.5227 Bent and Francel (1948)

## CARBON OXYSULPHIDE COS

**Constants:** Clusius and Weigand (1940)

*Melting curve*

| t° | p atm. | t° | p atm. | t° | p atm. |
|---|---|---|---|---|---|
| −138.68 | 12.93 | −138.79 | 4.38 | −138.85 | 0.001 |
| 138.73 | 8.86 | | | | |

*Triple point:* −138°85 and 0.001 atm.

## METHYLSULPHOXIDE $(CH_3)_2SO$

**Constants:** Douglas (1948)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|
| 20 | 0.417 | 35 | 1.195 | 45 | 2.27 |
| 25 | 0.600 | 40 | 1.656 | 50 | 3.07 |
| 30 | 0.853 | | | | |

*Heat of vaporisation:* (25°) 191.3 cal 15°/g

METHANE and ETHANESULPHONIC ACIDS: $SO_3HCH_3$ and $SO_3HC_2H_5$: *Density, viscosity surface tension* and *refractive index:* Berthoud (1929).

DIALKYL SULPHITES and SULPHATES: $R_2SO_3$ and $R_2SO_4$ ($R=CH_3$ to $C_5H_{11}$): *Boiling point, density, surface tension* and *refractive index:* Vogel and Cowan (1943).

TAURINE: $NH_2.(CH_2)_2.SO_3H$: *Specific heat:* Huffman and Fox (1940).

$\beta.\beta'$-DITHIODILACTIC ACID: $(SCH(CH_3)CO_2H)_2$, CYSTEINE: $HS\,CH_2CH(NH_2)CO_2H$ and CYSTINE: $(CO_2H\,CH(NH_2)\,CH_2\,S)_2$: *Specific heat* and *heat of combustion:* Huffman and Ellis (1935) and Becker and Roth (1934).

## THIOPHENOL $C_6H_5\,SH$

**Constants**

*Boiling point:* 169°5 Lecat

*Melting point:* −14°9 Parks, Todd and Moore (1936)

*Density*

| t° | d | | t° | d | |
|---|---|---|---|---|---|
| 25 | 1.0728 | Walden and Swinne | 23.2 | 1.0739 | Eisenlohr (1911) |
| 50 | 1.0491 | „ (1912) | | | |
| 75 | 1.0254 | „ | | | |

*Surface tension*

| t° | $\gamma$ | | t° | $\gamma$ | |
|---|---|---|---|---|---|
| 16.9 | 39.19 | Walden and Swinne | 58.0 | 34.10 | Walden and Swinne |
| 23.5 | 38.34 | „ (1912) | 76.4 | 32.02 | „ (1912) |
| 35.0 | 36.89 | „ | 93.5 | 30.32 | „ |

*Specific heat:* PARKS, TODD and MOORE (1936)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. −183.16 | 0.1271 | −123.16 | 0.1912 | −63.16 | 0.2403 | L. −13.16 | 0.3653 |
| −173.16 | 0.1363 | −113.16 | 0.1987 | −53.16 | 0.2508 | − 3.16 | 0.3699 |
| −163.16 | 0.1488 | −103.16 | 0.2061 | −43.16 | 0.2622 | + 6.84 | 0.3745 |
| −153.16 | 0.1691 | − 93.16 | 0.2138 | −33.16 | 0.2754 | 16.84 | 0.3792 |
| −143.16 | 0.1831 | − 83.16 | 0.2217 | −23.16 | 0.305 | 26.84 | 0.3838 |
| −133.16 | 0.1843 | − 73.16 | 0.2306 | | | | |

| | | |
|---|---|---|
| *Heat of melting* | 2490 cal 15° g | PARKS, TODD and MOORE (1936) |

## THIOPHEN $C_4H_4S$

### Constants

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | |
|---|---|---|---|---|---|---|
| C. −80.96 | 0.007 | L. −44.96 | 0.80 | +0.04 | 21.3 | MILAZZO (1944) |
| −75.96 | 0.015 | −35.16 | 1.98 | 5.24 | 28.5 | „ |
| −67.66 | 0.050 | −23.16 | 5.15 | 5.54 | 29.0 | „ |
| −62.96 | 0.095 | −12.96 | 9.5 | 13.54 | 44.0 | „ |
| −60.16 | 0.140 | − 6.56 | 14.5 | 16.24 | 49.5 | „ |
| 20.2 | 63.2 | 41.35 | 164.7 | 70.5 | 490 | NASINI (1929) |
| 25.05 | 79.8 | 50.6 | 243.4 | 79.9 | 641.5 | „ |
| 29.2 | 96.6 | 60.1 | 341 | 84.2 | 758.1 | „ |
| 71.0 | 500 | 81.45 | 700 | 89.7 | 900 | FAWCETT and RASMUS- |
| 76.6 | 600 | 85.5 | 800 | | | „ SEN (1945) |

*Boiling point*

| | | | |
|---|---|---|---|
| 84°0 | COULSON, HALES and HERINGTON (1948) | 84°3 | NASINI (1929) |
| 84°12 | FAWCET and RASMUSSEN (1945) | 84°7 | LECAT |
| 84°3 | THORPE and RODGER (1894) | 84°9 | EGGERS (1904) |

$\frac{dt}{dp}$ *(10 mm)* 0°43 FAWCETT and RASMUSSEN (1945)

*Freezing point*

| | |
|---|---|
| −38°30 | FAWCETT and RASMUSSEN (1945) |

*Density*

| t° | d | t° | d | |
|---|---|---|---|---|
| 11.8 | 1.07387 | 26.6 | 1.05662 | KNOPS (1888) |
| 16.5 | 1.06835 | 29.2 | 1.05332 | „ |
| 19.7 | 1.06466 | 32.0 | 1.05034 | „ |
| 23.4 | 1.06045 | | | „ |
| 13.7 | 1.0711 | 34.1 | 1.04770 | NASINI (1929) |
| 15.4 | 1.06966 | 56.2 | 1.02090 | „ |
| 30.3 | 1.0518 | | | „ |
| 20 | 1.0644 | 30 | 1.0524 | FAWCETT and RASMUSSEN (1945) |
| 25 | 1.0583 | | | „ |
| 20 | 1.0647 | | | COULSON, HALES and HERINGTON (1948) |

*Viscosity*

| t° | $\eta \cdot 10^5$ | t° | $\eta \cdot 10^5$ | |
|---|---|---|---|---|
| 20 | 662 | 30 | 584 | FAWCETT and RASMUSSEN (1945) |
| 25 | 621 | | | „ |

*Refractive index*

| t° | Hα | t° | D | t° | Hβ | t° | Hγ | |
|---|---|---|---|---|---|---|---|---|
| 16.3 | 1.525990 | 16.4 | 1.530777 | 16.3 | 1.543343 | 16.3 | 1.554216 | KNOPS (1888) |
| 20.2 | 1.523573 | 19.7 | 1.528736 | 20.1 | 1.540933 | 20.0 | 1.551859 | „ |
| 25.5 | 1.520280 | 24.6 | 1.525582 | 25.3 | 1.537538 | 24.9 | 1.548110 | „ |
| 28.2 | 1.518551 | 26.3 | 1.524454 | 27.6 | 1.536009 | 27.2 | 1.547186 | „ |
| $\frac{dn}{dt}$ | 0.000625 | | 638 | | 649 | | 645 | „ (for other temperatures, see author) |
| — | — | 20 | 1.5287 | — | — | — | — | FAWCETT and RASMUSSEN (1945) |
| — | — | 25 | 1.5256 | — | — | — | — | |
| — | — | 30 | 1.5223 | — | — | — | — | „ |
| — | — | $\frac{dn}{dt}$ | 0.00044 | — | — | — | — | „ |
| — | — | 20 | 1.5286 | — | — | — | — | COULSON, HALES and HERINGTON (1948) |

| | | 2-METHYLTHIOPHEN $C_4H_3(CH_3)S$ | | 3-METHYLTHIOPHEN $C_4H_3(CH_3)S$ | |
|---|---|---|---|---|---|
| **Constants:** FAWCETT (1946) | | | | | |
| *Boiling point* | | 112°5 | | 115°4 | |
| $\frac{dt}{dp}$ *(10 mm)* | | 0°46 | | 0°46 | |
| *Melting point* | | −63°5 | | A. −68°9<br>B. −74°1 | |
| *Density:* | 20° | 1.0194 | | 1.0216 | |
| | 25° | 1.0140 | | 1.0162 | |
| | 30° | 1.0086 | | 1.0110 | |
| *Viscosity:* $\eta \cdot 10^5$ | 0° | 944 | | 902 | |
| | 20° | 716 | | 687 | |
| | 25° | 669 | | 642 | |
| | 30° | 629 | | 607 | |
| *Refractive index* | | $n_D$ | $\frac{dn}{dt}$ | $n_D$ | $\frac{dn}{dt}$ |
| | 20° | 1.5203 | | 1.5204 | |
| | 25° | 1.5174 | 0.00059 | 1.5175 | 0.00058 |
| | 30° | 1.5144 | | 1.5146 | |

## 2-ACETYLTHIOPHEN $C_4H_3(CH_3CO)S$

**Constants:** JOHNSON (1947)

*Boiling point:* 231°90 $\frac{dt}{dp}$ *(10 mm):* 0°55

*Freezing point:* 10°425

*Density:* 20° 1.1709

*Viscosity* $\eta \cdot 10^4$ 30° 232

*Surface tension:* 30° 44.5

*Refractive index*

| t° | D | Hg gr. | Hg bl. |
|---|---|---|---|
| 20 | 1.5667 | 1.5727 | 1.6017 |
| $\frac{dn}{dt}$ | 0.00049 | 49 | 49 |

2-NITROTHIOPHEN: $C_4H_3NO_2S$ and 2,5-DINITROTHIOPHEN: $C_4H_2(NO_2)_2S$: *Saturated vapour pressure* and *melting point*: BABASINIAN and JACKSON (1929); *Melting point*: STEINKOPF (1914) and MEYER and STADLER (1884).

# 14. DERIVATIVES WITH OTHER ELEMENTS

DIPHENYLSELENIDE: $(C_6H_5)_2$ Se: *Density, surface tension* and *refractive index:* VOGEL and COWAN (1943).

CARBONSULPHOSELENIDE: CSSe: *Boiling point, density* and *surface tension:* BRISCOE, PEEL and ROBINSON (1929).

TRIETHYLPHOSPHINE: $(C_2H_5)_3P$: *Saturated vapour pressure:* THOMPSON and LINNETT (1936); *density* and *refractive index:* JONES, DAVIES and DYKE (1933). Other PHOSPHINES and other PHOSPHORUS-CONTAINING COMPOUNDS: JONES, DAVIES and DYKE (1933).

TRIPHENYLPHOSPHINE: $(C_6H_5)_3P$: *Saturated vapour pressure, melting point, density* and *surface tension*: FORWARD, BOWDEN and JONES (1949)

A series of ORTHOPHOSPHATES: $PO_4R_3$($R=CH_3 \rightarrow C_5H_{11}$) VOGEL and COWAN (1943).

2-CHLOROVINYLDICHLOROARSINE: $(CH_2=CCl)Cl_2$ As *cis*: *Saturated vapour pressure, boiling* and *melting points, density, viscosity* and *refractive index:* WHITING (1948).

DIPHENYLCYANOARSINE: $(C_6H_5)_2CN$ As: *Saturated vapour pressure*: BALSON (1947)

TRIPHENYLARSINE, STIBINE and BISMUTHINE: $(C_6H_5)_3As$; $(C_6H_5)_3Sb$; $(C_6H_5)_3Bi$: *Saturated vapour pressure, melting point, density* and *surface tension*: FORWARD, BOWDEN and JONES (1949)

## TETRAMETHYLSILANE $(CH_3)_4$ Si

**Constants:** ASTON, KENNEDY and MESSERLY (1941)

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| −64.22 | 6.24 | −23.11 | 90.79 | +1.41 | 289.35 | 15.25 | 503.41 |
| −55.98 | 11.71 | −17.08 | 123.78 | 8.83 | 392.31 | 19.46 | 588.54 |
| −36.99 | 41.50 | − 9.43 | 178.77 | 9.79 | 407.57 | 20.49 | 611.29 |
| −30.31 | 61.28 | − 3.97 | 229.12 | 14.81 | 494.99 | | |

| *Boiling point* | | *Freezing point* | | | | | |
|---|---|---|---|---|---|---|---|
| 26°64 | | (α) | unst. form | −102°12 | (β) | st. form | −99°04 |

*Specific heat* (M.W. 88.197)

| t° | $c_p$ | t° | $c_p$ | t° | $c_p$ | t° | $c_p$ |
|---|---|---|---|---|---|---|---|
| C. β −260.87 | 0.00990 | −209.11 | 0.16995 | −127.94 | 0.3298 | −63.81 | 0.4649 |
| −258.77 | 0.01663 | −204.00 | 0.18219 | −121.43 | 0.3417 | −58.94 | 0.4683 |
| −256.73 | 0.02305 | −199.15 | 0.19429 | −115.03 | 0.3548 | −53.34 | 0.4723 |
| −254.90 | 0.02808 | −194.16 | 0.20689 | −108.99 | 0.3654 | −47.65 | 0.4753 |
| −253.12 | 0.03531 | −188.77 | 0.21874 | −104.51 | 0.3935 | −42.33 | 0.4787 |
| −251.38 | 0.04186 | −183.36 | 0.22911 | −101.76 | 0.4609 | −36.75 | 0.4842 |
| −248.98 | 0.04774 | −178.11 | 0.24053 | C. α −105.54 | 0.4196 | −30.61 | 0.4854 |
| −245.28 | 0.06114 | −172.72 | 0.2516 | −104.69 | 0.4621 | −22.66 | 0.4932 |
| −240.32 | 0.07764 | −167.03 | 0.2633 | −103.98 | 0.5396 | −16.83 | 0.4962 |
| −236.04 | 0.09043 | −161.25 | 0.2730 | L. − 94.75 | 0.4456 | −10.33 | 0.5016 |
| −231.89 | 0.1022 | −155.80 | 0.2814 | − 90.04 | 0.4486 | − 3.39 | 0.5070 |
| −226.95 | 0.11673 | −150.73 | 0.2870 | − 84.26 | 0.4544 | + 3.01 | 0.5138 |
| −222.02 | 0.13390 | −145.47 | 0.3003 | − 78.66 | 0.4564 | 9.35 | 0.5200 |
| −216.87 | 0.14584 | −140.01 | 0.3098 | − 74.32 | 0.4589 | 15.24 | 0.5329 |
| −215.47 | 0.15056 | −134.00 | 0.3196 | − 67.21 | 0.4645 | 20.37 | 0.5485 |
| −211.62 | 0.16166 | | | | | | |

| | | | |
|---|---|---|---|
| *Heat of vaporisation* | 26°64 | 65.59 | cal 15°/g |
| *Heat of melting* | α | 16.177 | „ |
| | β | 18.643 | „ |

METHYL CHLORO, METHYL FLUORO, METHYL CHLOROFLUOROSILANES: $(CH_3)_2Cl_2Si$, $CH_3Cl_3Si$, $CH_3F_3Si$, $CH_3ClF_2Si$ and $CH_3Cl_2FSi$:
*Saturated vapour pressure, boiling* and *melting point, heat of vaporisation:* Booth and Martin (1946); *density:* Balis, Gilliam, Hadsell, Liebhafsky and Winslow (1948).

## ETHYL ORTHOSILICATE $Si(O C_2H_5)_4$

**Constants:** Solana and Moles (1932)

*Critical temperature:* 611°

*Saturated vapour pressure*

| t° | p mm | t° | p mm | t° | p mm | t° | p mm |
|---|---|---|---|---|---|---|---|
| 24.8 | 2.8 | 114.2 | 148.5 | 138.6 | 328.3 | 165.3 | 701.3 |
| 39.5 | 6.1 | 121.0 | 183.3 | 141.7 | 358.6 | 165.8 | 708.2 |
| 60.1 | 18.0 | 122.3 | 191.1 | 146.2 | 407.5 | 168.2 | 754.0 |
| 66.0 | 21.6 | 123.5 | 202.0 | 149.0 | 449.0 | 170.2 | 794.0 |
| 80.6 | 41.8 | 124.7 | 211.3 | 153.5 | 511.6 | 171.5 | 812.8 |
| 82.8 | 45.4 | 128.5 | 231.1 | 157.3 | 560.9 | 172.8 | 849.8 |
| 93.1 | 66.4 | 130.7 | 249.0 | 162.9 | 653.5 | 173.2 | 863.6 |
| 107.2 | 109.6 | 132.6 | 270.0 | | | | |

| *Boiling point* | | *Melting point* |
|---|---|---|
| 168°55 | | −82°5 |
| 168°8 | Lecat | |

*Density and viscosity*

| t° | d | $\eta_i \cdot 10^4$ | t° | d | $\eta_i \cdot 10^4$ | t° | d | $\eta_i \cdot 10^4$ |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.95558 | — | 25 | 0.92939 | 6556 | 50 | 0.90192 | 4972 |
| 5 | 0.95028 | — | 30 | 0.92384 | 6161 | 58 | 0.89307 | 4579 |
| 10 | 0.94485 | 7926 | 35 | 0.91840 | 5812 | 66 | 0.88446 | 4273 |
| 15 | 0.93964 | 7395 | 40 | 0.91295 | 5507 | 73 | 0.87730 | 4056 |
| 20 | 0.93456 | 6939 | 45 | 0.90741 | 5216 | | | |

*Refractive index*

| | |
|---|---|
| $n_D^{16°}$ | 1.38169 |

| Constants: BURG (1940) | METHYLBORIC ANHYDRIDE $(CH_3BO)_3$ | | | | METHYLBORIC ACID $CH_3B(OH)_2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
| *Saturated vapour pressure* | L. 0.0 | 20.5 | 32.2 | 113.0 | C. 25 | 2.5 | 57 | 31 |
| | 14.3 | 46.5 | 39.9 | 161.5 | 31 | 4.2 | 61 | 42 |
| | 21.7 | 67.8 | 47.7 | 227.1 | 41 | 9.3 | 65 | 55 |
| | 24.8 | 79.2 | 54.8 | 304.7 | 45 | 13.0 | | |
| *Boiling point* | 79° | | | | — | | | |
| *Melting point* | −38° | | | | — | | | |

| Constants: BURG (1940) | METHYLBORODIFLUORIDE $BCH_3F_2$ | | | | DIMETHYLBOROFLUORIDE $B(CH_3)_2F$ | | | |
|---|---|---|---|---|---|---|---|---|
| | t° | p mm | t° | p mm | t° | p mm | t° | p mm |
| *Saturated vapour pressure* | −98.6 | 62.4 | −80.9 | 242.7 | −112 | 6.0 | −78.7 | 93.06 |
| | −95.7 | 80.0 | −78.7 | 281.8 | −96.0 | 25.2 | −64.5 | 230.1 |
| | −94.2 | 90.0 | −69.0 | 524 | −84.6 | 61.0 | −45.9 | 633 |
| | −91.1 | 116.4 | −64.3 | 681 | | | | |
| | −85.9 | 170.6 | | | | | | |
| *Boiling point* | − 62°3 | | | | −42°2 | | | |
| *Melting point* | −130°45 | | | | −147°35 | | | |

METHYL and ETHYL BORATES: $B(OCH_3)_3$ and $B(OC_2H_5)_3$: *Boiling point, density* and *surface tension:* ETRIDGE and SUGDEN (1928); *boiling point:* LECAT.

## 15. ADDENDA

We have become acquainted with the following works too late to include them in the tables:

CARLEY and BERTELSEN (1949): Carbon tetrachloride

D'HONDT and JUNGERS (1949): 1,1-Dibromoethane and 1,1,2-Tribromoethane

DREISBACH and SHRADER (1949) and DREISBACH and MARTIN (1949): Carbon tetrachloride, 1,2-Dichloropropane, *n*-Butyl bromide and *o*-Dichlorobenzene

A. F. FORZIATI, W. R. NORRIS and F. D. ROSSINI, J. Research Nat. Bur. Standards, 43, 555 (1949): vapour pressures and boiling points of paraffins in $C_7$ and $C_9$, alkyl*cyclo*pentanes, alkyl*cyclo*hexanes and alkylbenzenes

A. F. FORZIATI and F. D. ROSSINI, J. Research Nat. Bur. Standards, 43, 473 (1949) give some constants of many hydrocarbons. The agreement with values given in this book is usually very good; the only discrepancies occur for 1,2,3-Trimethylbenzene (hemimellitene), 1,2,4-Trimethylbenzene (*pseudo*-Cumene) and Ethyl*cyclo*pentane.

NICOLINI and LAFFITE (1949): Methyl*cyclo*hexane, Di*iso*propyl ether, Dimethylacetal, Diethylacetal, Dimethylformal, Diethylformal

SEYER, BENNETT and WILLIAMS (1949): Hexamethylethane

STEINHAUSER and WHITE (1949): *n*-Heptane, Benzene and Toluene

WADDINGTON, SMITH, SCOTT and HUFFMAN (1949): 2-Methylpentane and 2,3-Dimethylbutane (cf. HOWARD, MEARS, etc. (1947), see p. 645, and FORZIATI, GLASGOW, Jr., etc. (1946), see p. 641).

*Corrigenda*

VON GROSSE, see GROSSE
HALBAN, see VON HALBAN
KOLOSSOWSKI, see DE KOLOSSOWSKI
LEE, see VAN DER LEE
NARBUTT, see VON NARBUTT
REIS, see VON REIS
SCHNEIDER, see VON SCHNEIDER

p. 98, density of *n*-Nonane, the value 0.71328 should read 0.71398.

p. 127, in the last columns of the first table, (work of SCOTT, WADDINGTON, etc.) the pressure in mm should be replaced as follows:

| t° | p mm |
|---|---|
| 46.728 | 1268.0 |
| 52.005 | 1489.3 |
| 57.320 | 1740.9 |
| 62.675 | 2025.8 |

N.B. The pressures in mm indicated by the same authors for Pentane (p. 124) and the 2-Methylbutenes (p. 127 and 128) are not exactly equal, but differ by some hundredths of a mm.

p. 139, under the table of the specific heats of Butyne-2, Between 130° and 110° should read Between −130° and −110°.

p. 272, for *sec.* Hexyl fluoride, the surface tension is 20.39 and not —. The refractive index is measured at 20° and not at 20·39.

# BIBLIOGRAPHY

# 1. HISTORICAL

The honour of having undertaken the first systematic investigation on the physical constants of pure organic compounds belongs to KOPP (1842).

For a long time afterwards, there were but few chemists who carried out research of this nature. During about half a century, only the classical works of MENDELEEF on ethyl alcohol, of DE VISSER on acetic acid, and of REGNAULT, were outstanding. This state of affairs lasted until the study of stoichiometric relations made necessary the preparation of a large number of organic compounds in a state of purity, and the precise determination of their constants.

An early group of investigators undertook such a systematic research about 1885; in particular may be mentioned LOSSEN and GARTENMEISTER, of the laboratory of Konigsberg, who continued and extended the determinations of KOPP on molecular volumes.

They were followed by BRÜHL, whose determinations of refractive indices are classic; SCHIFF made an important contribution to the study of capillary constants; THORPE, the first good measurements of viscosity; and PERKIN those of the magnetic rotatory power of organic compounds. All these scientists paid special attention to the purification of their samples and, in many cases, their results have been confirmed by contemporary authors.

At about the same time S. YOUNG, at first in collaboration with RAMSAY, and later alone, undertook his magnificent series of researches on the experimental control of the equation of state of pure fluids; in this work he studied some thirty organic compounds which were purified with extreme care, and made use of the constancy of the isothermal saturated vapour pressure as an exceptionally sensitive criterion of purity. These researches, which made their author famous, extended over the whole of his scientific career, and may be considered as a model for this type of long and careful work.

Since the beginning of the present century, the study of these problems has been taken up in a large number of laboratories, and among the noteworthy results obtained there should be mentioned those of EYKMAN for the measurements of refractive indices and of PICKARD and KENYON for rotatory power; further reference may also be made to the work of PARKS and that of ANDREWS on specific heats and heats of transformation; finally, among contemporary authors, LOWRY (simple and rotatory dispersion), SWIETOSLAWSKI, KEFFLER and VERKADE (heats of combustion).

The study of the constants of pure gases forms a special sphere reserved to a few well-known centres of research: Leduc and Kuenen played the part of pioneers in this direction; the most important investigations have been carried out by Kamerlingh Onnes and his collaborators at the Cryogenic laboratory at Leyden, and later also by Michels at the laboratory of Van der Waals in Amsterdam; another school is that of Ph. A. Guye of Geneva which includes in addition to its founder, Baume, Cardoso, and Moles; the latter has brilliantly carried on the traditions of his master at Madrid. During the last fifteen years Clusius, at Munich, has also made some notable investigations on the properties of gases.

Only the great national laboratories of different countries possess the resources and the staff necessary for certain long-term projects; they have accordingly played an important part in the study of pure compounds. In the realm of organic compounds, the National Bureau of Standards at Washington is specially distinguished by the researches of Dickinson on the heat of combustion, those of Burgess on thermometric standards, and by the work of Washburn on the separation, in a state of purity, of the hydrocarbons of petroleum. In Russia, the Institute of Pure Reagents of the U.S.S.R., under the direction of Longinoff has carried on the tradition of Mendeleef by the study of anhydrous alcohols, completing the great work devoted to ethyl alcohol by Osborne and MacKelvy (National Bureau of Standards of Washington).

For some forty years the Belgian chemical school has attached great importance to the study of very pure organic compounds, and this favourable environment has undoubtedly contributed to the establishment of the International Bureau of Physico-chemical Standards at Brussels, where the usual constants of nearly two hundred organic compounds—those most frequently used in physico-chemical works—have been studied. Further evidence of the same tendency is given by the interest shown in these problems by organic chemists who, in Belgium, co-operate with the physico-chemists. Following the classical work of Crismer on anhydrous alcohols, there should be mentioned the researches carried out by Swarts at Ghent (refractive indices and heats of combustion of fluorine compounds), by Chavanne at Brussels (hydrocarbons of petroleum and *cis-trans* halogenated derivatives), and finally those of Bruylants at Louvain (densities and refractive indices in the homologous series of paraffins, nitriles, etc.).

The importance of this work has received particular recognition from the International Union of Pure and Applied Chemistry, of which several permanent commissions are devoted to this type of study; outside the International Bureau of Physico-chemical Standards mention may be made in particular of the publications of the Committee of Thermochemistry and those of the New Committee

of Physico-chemical Data; SWIETOSLAWSKI, who has presided successively over these two committees, is notable for his personal researches, of great importance, on the heat of combustion of organic compounds; and the ebulliometric, cryometric and calorimetric methods which he has perfected during recent years will become the starting point for an important advance in the development of this branch of science.

The contributions of the American school during the last war were very important and valuable. At the National Bureau of Standards, ROSSINI and his colleagues, working in collaboration with the American Petroleum Institute, carried out an important work on the hydrocarbons of which the chief results are collected in their "Selected Values of Properties of Hydrocarbons" (1946–1949). We could not always take into account these numerical data, as they were abstracted from unpublished work, of unknown accuracy. Moreover a large number of U.S. university laboratories have studied the variation of entropy as a function of temperature, for a number of organic compounds; in particular ASTON in Pennsylvania and GIAUQUE in California were very fortunate in this field.

Reviewing the bulk of the publications on the subject of the present work, one cannot help being struck by the great inequality in the part taken by different nations in the study of the problem of pure organic compounds; certainly it appears that this type of research hardly succeeds in retaining the attention of French and German chemists. It is curious on the other hand, to note how the Anglo-Saxon physico-chemists have distinguished themselves in this sphere for a long time. Already in 1794, CAVENDISH had measured, with remarkable accuracy for his time, the constants of the gases which he was studying; later FARADAY in his turn took up this kind of work.

Since then, this predilection of English and American chemists has continued, and the development, in Belgium, of a school of research in this particular branch of science is, to some extent, the result of the indirect influence of S. YOUNG; while important American publications are due to CALINGAERT and HENNE, former pupils of Brussels University.

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N.B. — The references have been collected till the beginning of 1950.

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# INDEXES

# 1. FORMULA INDEX

Unless otherwise indicated, all compounds in which the possibility of structural isomerism arises, are assumed to be the normal (*n*-) isomerides.


## $C_1$

$CD_4$ Deuteromethane, 22
$CFCl_3$ Monofluorotrichloromethane, 229
$CF_2Cl_2$ Difluorodichloromethane, 230
$CF_4$ Carbon tetrafluoride, 223
— Tetrafluoromethane, 223
CClN Cyanogen chloride, 602
$CCl_2O$ Carbonyl chloride, 506
— Phosgene, 506
$CCl_3NO_2$ Chloropicrin, 604
— Trichloronitromethane, 604
$CCl_4$ Carbon tetrachloride, 224, 628
— Tetrachloromethane, 224, 628
$CBr_4$ Carbon tetrabromide, 228
— Tetrabromomethane, 228
CIN Cyanogen iodide, 602
$CN_4O_8$ Tetranitromethane, 578
CO Carbon monoxide, 365
COS Carbon oxysulphide, 620
$CO_2$ Carbon dioxide, 369
CSSe Carbonsulphoselenide, 625
$CS_2$ Carbon disulphide, 610
$CHFCl_2$ Monofluorodichloromethane, 222
$CHF_2Cl$ Difluoromonochloromethane, 222
$CHCl_2Br$ Dichloromonobromomethane, 223
$CHCl_3$ Chloroform, 218
— Trichloromethane, 218
$CHBr_3$ Bromoform, 221
— Tribromomethane, 221
$CHI_3$ Iodoform, 222
— Triiodomethane, 222
CHN Hydrogen cyanide, 525
CHNO Cyanic acid, 588
$CH_2Cl_2$ Methylene dichloride, 215
$CH_2Br_2$ Methylene dibromide, 216
$CH_2I_2$ Methylene diiodide, 217
$CH_2O$ Formaldehyde, 352
$CH_2O_2$ Formic acid, 377
$CH_3D$ Monodeuteromethane, 23
$CH_3F$ Methyl fluoride, 210
$CH_3FCl_2Si$ Methylmonofluorodichlorosilane, 626
$CH_3F_2ClSi$ Methyldifluoromonochlorosilane, 626
$CH_3F_2B$ Methylborodifluoride, 627
$CH_3F_3Si$ Methyltrifluorosilane, 626
$CH_3Cl$ Methyl chloride, 211
$CH_3Cl_3Si$ Methyltrichlorosilane, 626
$CH_3Br$ Methyl bromide, 213
$CH_3I$ Methyl iodide, 214
$CH_3NO$ Formamide, 582
$CH_3NO_2$ Nitromethane, 577
$CH_4$ Methane, 19
$CH_4N_2O$ Carbamide, 583
— Urea, 583
$CH_4O$ Methyl alcohol, 302
$CH_4O_3S$ Methylsulphonic acid, 621
$CH_4S$ Methyl mercaptan, 614
$CH_5N$ Methylamine, 517
$CH_5O_2B$ Methaneboronic acid, 627
$CH_6ClN$ Methylammonium chloride, 604

## $C_2$

$C_2F_2Cl_4$ 1,2-Difluoro-tetrachloroethane, 249
$C_2F_3Cl$ Trifluoromonochloroethylene, 279
$C_2F_3Cl_3$ 1,1,2-trifluoro-1,2,2-trichloroethane, 249
$C_2Cl_4$ Tetrachloroethylene, 278
$C_2Cl_6$ Hexachloroethane, 248
$C_2N_2$ Cyanogen, 547
— Oxalonitrile, 547
$C_2S_3$ Carbon sesquisulphide, 614
$C_2HF_3O_2$ Trifluoroacetic acid, 509
$C_2HCl_2Br_3$ 1,1-Dichloro-1,2,2-tribromo-ethane, 246
$C_2HCl_5$ Pentachloroethane, 247
$C_2H_2$ Acetylene, 138
$C_2H_2FCl_3$ 1-Fluoro-1,2,2-trichloroethane, 245
$C_2H_2F_2Cl_2$ 1,1-Difluoro-2,2-dichloroethane, 246
$C_2H_2F_2O_2$ Difluoroacetic acid, 509
$C_2H_2ClN$ α-Chloroacetonitrile, 603
$C_2H_2Cl_2$ 1,1-Dichloroethylene, 276
— 1,2-Dichloroethylene, 277
— Vinylidene chloride, 276

$C_2H_2Cl_2Br_2$ 1,1-Dichloro-1,2-dibromoethane, 246
$C_2H_2Cl_3As$ 2-Chlorovinyldichloroarsine, 625
$C_2H_2Cl_4$ Acetylene tetrachloride, 244
— 1,1,2,2-Tetrachloroethane, 244
$C_2H_2Br_4$ Acetylene tetrabromide, 245
— 1,1,2,2-Tetrabromoethane, 245
$C_2H_2I_2$ 1,2-Diiodoethylene, 278
$C_2H_2O_4$ Oxalic acid, 403
$C_2H_3F_2Br$ 1,1-Difluoro-2-bromoethane, 243
$C_2H_3F_3$ Methylfluoroform, 240
— 1,1,1-Trifluoroethane, 240
$C_2H_3F_3O$ 2,2,2-Trifluoroethyl alcohol, 508
$C_2H_3Cl$ Monochloroethylene, 276
— Vinyl chloride, 276
$C_2H_3Cl_3$ Methylchloroform, 242
— 1,1,1-Trichloroethane, 242
— 1,1,2-Trichloroethane, 241
$C_2H_3ClO$ Acetyl chloride, 510
$C_2H_3ClO_2$ Monochloroacetic acid, 509
$C_2H_3Br$ Monobromoethylene, 276
— Vinyl bromide, 276
$C_2H_3BrO_2$ Monobromoacetic acid, 510
$C_2H_3Br_3$ 1,1,2-Tribromoethane, 628
$C_2H_3IO_2$ Monoiodoacetic acid, 510
$C_2H_3N$ Acetonitrile, 527
— Methyl cyanide, 527
$C_2H_4$ Ethylene, 115
$C_2H_4F_2O$ 2,2-Difluoroethyl alcohol, 508
$C_2H_4Cl_2$ 1,1-Dichloroethane, 238
— 1,2-Dichloroethane, 236
— Ethylene dichloride, 236
— Ethylidene dichloride, 238
$C_2H_4Br_2$ 1,2-Dibromoethane, 239, 628
— Ethylene dibromide, 239
$C_2H_4N_2O_6$ Ethylene glycol dinitrate, 578
$C_2H_4O$ Acetaldehyde, 352
— Epoxyethane, 499
— Ethylene oxide, 499
$C_2H_4O_2$ Acetic acid, 380
— Methyl formate, 406
$C_2H_5F$ Ethyl fluoride, 231
$C_2H_5FO$ Ethylene fluorohydrin, 508
— 2-Fluoroethyl alcohol, 508
$C_2H_5Cl$ Ethyl chloride, 231
$C_2H_5ClO$ 2-Chloroethyl alcohol, 507
— Ethylene chlorohydrin, 507
$C_2H_5Br$ Ethyl bromide, 233
$C_2H_5I$ Ethyl iodide, 235
$C_2H_5NO$ Acetamide, 583
$C_2H_5NO_2$ Ethyl nitrite, 578
$C_2H_6$ Ethane, 24
$C_2H_6FB$ Dimethylborofluoride, 627
$C_2H_6Cl_2Si$ Dimethyldichlorosilane, 626
$C_2H_6O$ Dimethyl ether, 339
— Ethyl alcohol, 306
$C_2H_6OS$ Methylsulphoxide, 621
$C_2H_6O_2$ Ethylene glycol, 334
$C_2H_6O_3S$ Dimethyl sulphite, 621
— Ethanesulphonic acid, 621
$C_2H_6O_4S$ Dimethylsulphate, 621
$C_2H_6S$ Dimethyl sulphide, 616
— Ethyl mercaptan, 615
$C_2H_7N$ Dimethylamine, 520
— Ethylamine, 519
$C_2H_7NO$ Monoethanolamine, 588
$C_2H_7NO_3S$ Taurine, 621
$C_2H_8N_2$ Ethylenediamine, 524

## $C_3$

$C_3HCl_7$ 1,1,1,2,2,3,3-Heptachloropropane, 260
$C_3H_2N_2$ Malonitrile, 548
— Methylene dicyanide, 548
$C_3H_3N$ Acrylonitrile, 542
$C_3H_4$ Allylene, 138
— Methylacetylene, 138
— Propyne, 138
$C_3H_4ClN$ α-Chloropropionitrile, 603
$C_3H_4Cl_2$ 1,3-Dichloropropene, 280
$C_3H_4O$ Acrolein, 353
— Acrylic aldehyde, 353
$C_3H_4O_2$ Acrylic acid, 404
$C_3H_4O_4$ Malonic acid, 404
$C_3H_5F_3O$ β,β,β-Trifluoro*iso*propyl alcohol, 508
$C_3H_5Cl$ Allyl chloride, 280
$C_3H_5ClO$ Propionyl chloride, 510
$C_3H_5Cl_3$ 1,2,3-Trichloropropane, 260
$C_3H_5N$ Ethylcarbylamine, 550
— Ethyl cyanide, 529
— Ethyl *iso*cyanide, 550
— Propionitrile, 529
$C_3H_5N_3O_9$ Glyceryl trinitrate, 581
— Nitroglycerin, 581
$C_3H_6$ Cyclopropane, 183
— Propene, 117
$C_3H_6Cl_2$ 1,2-Dichloropropane, 256, 628
— 2,2-Dichloropropane, 257
— 1,3-Dichloropropane, 258
— Propylene dichloride, 256
— *iso*Propylidene dichloride, 257
— Trimethylene dichloride, 258
$C_3H_6Br_2$ 1,2-Dibromopropane, 259
— 1,3-Dibromopropane, 259
— Propylene dibromide, 259
— Trimethylene dibromide, 259
$C_3H_6N_2O_6$ Propylene glycol dinitrate, 580

$C_3H_6N_2O_6$ Trimethylene glycol dinitrate, 580
$C_3H_6O$ Acetone, 353
— Allyl alcohol, 333
$C_3H_6O_2$ Ethyl formate, 408
— Methyl acetate, 412
— Propionic acid, 383
$C_3H_7Cl$ Propyl chloride, 250
— *iso*Propyl chloride, 251
$C_3H_7Br$ Propyl bromide, 252
— *iso*Propyl bromide, 253
$C_3H_7I$ Propyl iodide, 254
— *iso*Propyl iodide, 255
$C_3H_7NO$ Propionamide, 583
$C_3H_7NO_2S$ Cysteine, 621
$C_3H_7NO_2$ Alanine, 587
— Ethyl carbamate, 589
— Propyl nitrite, 578
— Urethan, 589
$C_3H_8$ Propane, 25
$C_3H_8O$ Methylethyl ether, 348
— Propyl alcohol, 313
— *iso*Propyl alcohol, 316
$C_3H_8O_2$ Dimethoxymethane, 350, 628
— Dimethylformal, 350, 628
— Methylal, 350, 628
$C_3H_8O_3$ Glycerol, 336
$C_3H_9N$ Propylamine, 524
— Trimethylamine, 522
$C_3H_9O_3B$ Trimethyl borate, 627
$C_3H_9O_3B_3$ Methaneboronic anhydride, 627
$C_3H_9O_4P$ Trimethyl orthophosphate, 625
$C_3H_{12}N_6O_3$ Guanidine carbonate, 587

## $C_4$

$C_4H_2F_6O_2$ $\beta,\beta,\beta$-Trifluoroethyl trifluoroacetate, 513
$C_4H_2N_2O_4S$ 2,5-Dinitrothiophen, 624
$C_4H_2O_3$ Maleic anhydride, 503
$C_4H_3NO_2S$ 2-Nitrothiophen, 624
$C_4H_4ClN$ $\gamma$-Chlorocrotonitrile, 603
— $\beta$-Chloromethylacrylonitrile, 603
$C_4H_4Cl_2O_2$ Succinoyl chloride, 511
$C_4H_4BrN$ 1-Bromocrotonitrile, 603
$C_4H_4N_2$ Ethylene dicyanide, 549
— Succinonitrile, 549
$C_4H_4O_4$ Fumaric acid, 405
— Maleic acid, 405
$C_4H_4S$ Thiophen, 622
$C_4H_5F_3O_2$ Ethyl trifluoroacetate, 513
— $\beta,\beta,\beta$-Trifluoroethyl acetate, 512
$C_4H_5ClO_2$ $\beta$-Chlorocrotonic acid, 510
— $\beta$-Chloro*iso*crotonic acid, 510
$C_4H_5Cl_3O_2$ Ethyl trichloroacetate, 513
$C_4H_5N$ Crotonitrile, 542
$C_4H_5N$ *iso*Crotonitrile, 543
—, Vinylacetonitrile, 544
$C_4H_5NS$ Allyl *iso*thiocyanate, 619
$C_4H_6$ Butadiene-1,3, 135
— Butyne-2, 139, 628
— 1,2-Dimethylacetylene, 139
$C_4H_6F_2O_2$ $\beta,\beta$-Difluoroethyl acetate, 512
— Ethyl difluoroacetate, 513
$C_4H_6ClN$ $\alpha$-Chlorobutyronitrile, 603
— $\gamma$-Chlorobutyronitrile, 603
— $\beta$-Chloro*iso*butyronitrile, 603
$C_4H_6Cl_2O_2$ Ethyl dichloroacetate, 513
$C_4H_6BrNO$ $\alpha$-Bromocrotonamides, 604
$C_4H_6O$ Divinyl ether, 350
$C_4H_6O_2$ Crotonic acid, 404
— Vinyl acetate, 421
$C_4H_6O_3$ Acetic anhydride, 375
$C_4H_6O_4$ Succinic acid, 403
$C_4H_7FO_2$ Ethyl fluoroacetate, 513
— $\beta$-Fluoroethyl acetate, 512
$C_4H_7F_3O$ $\gamma,\gamma,\gamma$-Trifluoro*iso*butyl alcohol, 512
$C_4H_7ClO_2$ Ethyl chloroacetate, 513
$C_4H_7BrO_2$ Ethyl bromoacetate, 514
— Methyl bromopropionate, 514
$C_4H_7N$ Butyronitrile, 531
— *iso*Butyronitrile, 532
— Propyl cyanide, 531
— *iso*Propyl cyanide, 532
$C_4H_7NO$ Crotonamide, 585, 586, 587
$C_4H_8$ Butene-1, 119
— *cis*-Butene-2, 120
— *iso*Butene, 123
— *trans*-Butene-2, 122
— 2-Methylpropene-1, 123
$C_4H_8Cl_2O$ Dichloroethyl ether, 508
$C_4H_8Cl_2S$ $\beta\beta'$-Dichlorodiethyl sulphide, 620
— Mustard gas, 620
— Yperite, 620
$C_4H_8N_2O_3$ Glycylglycine, 587
$C_4H_8N_2O_7$ Diethylene glycol dinitrate, 579
$C_4H_8O$ Methylethylketone, 360
— Methylvinylcarbinol, 334
$C_4H_8O_2$ Butyric acid, 386
— *iso*Butyric acid, 388
— Dioxan, 502
— Ethyl acetate, 415
— Methyl propionate, 421
— Propyl formate, 410
$C_4H_9F$ Butyl fluoride, 261
— *sec.*Butyl fluoride, 261
$C_4H_9Cl$ Butyl chloride, 261
— *iso*Butyl chloride, 262
— *sec.*Butyl chloride, 262
— *tert.*Butyl chloride, 264

$C_4H_9Br$ Butyl bromide, 265, 628
— *iso*Butyl bromide, 266
— *sec.*Butyl bromide, 267
— *tert.*Butyl bromide, 268
$C_4H_9I$ Butyl iodide, 268
— *iso*Butyl iodide, 269
— *sec.*Butyl iodide, 270
$C_4H_9NO$ Butyramide, 584, 586, 587
$C_4H_{10}$ Butane, 27
— *iso*Butane, 29
— 2-Methylpropane, 29
$C_4H_{10}O$ Butyl alcohol, 318
— *iso*Butyl alcohol, 320
— *sec.*Butyl alcohol, 322
— *tert.*Butyl alcohol, 324
— Diethyl ether, 341
— Methylpropyl ether, 349
— Trimethylcarbinol, 324
$C_4H_{10}O_2$ 1,1-Dimethoxyethane, 628
— Dimethylacetal, 628
$C_4H_{10}O_3S$ Diethyl sulphite, 621
$C_4H_{10}O_4$ Erythritol, 338
$C_4H_{10}O_4S$ Diethyl sulphate, 621
$C_4H_{10}S$ Diethyl sulphide, 618
$C_4H_{11}N$ Butylamine, 524
— Diethylamine, 521
$C_4H_{11}N_3O_3$ Creatine hydrate, 587
$C_4H_{12}IN$ Tetramethylammonium iodide, 605
$C_4H_{12}Si$ Tetramethylsilane, 625

## $C_5$

$C_5F_{10}$ Perfluorocyclopentane, 301
$C_5F_{12}$ Amyl perfluoride, 272
— *iso*Amyl perfluoride, 272
— Perfluoropentane, 272
— Perfluoro-*iso*pentane, 272
$C_5HF_9$ Nonafluorocyclopentane, 301
$C_5HF_{11}$ Undecafluoropentane, 272
— Undecafluoro*iso*pentane, 272
$C_5H_4N_2$ Citraconitrile, 547
— Mesaconitrile, 547
$C_5H_4O_2$ Furfural, 501
$C_5H_5N$ Pyridine, 568
$C_5H_6N_2$ Glutaronitrile, 550
— Trimethylene dicyanide, 550
$C_5H_6S$ 2-Methylthiophen, 624
— 3-Methylthiophen, 624
$C_5H_7F_3O_2$ $\beta,\beta,\beta$-Trifluoro*iso*propyl acetate, 512
$C_5H_7N$ Pentene(4)nitrile, 545
$C_5H_8$ Cyclopentene, 191
— Isoprene, 137
— 2-Methylbutadiene-1,3, 137
— Pentadiene-1,4, 136
$C_5H_8ClN$ α-Chlorovaleronitrile, 603
$C_5H_8Cl_2$ Cyclopentylidene chloride, 301
$C_5H_8O$ Cyclopentanone, 490
$C_5H_8O_2$ Allylacetic acid, 404
— Angelic acid, 404
— Dimethylacrylic acid, 404
— Methyl crotonate, 453
— Penten(4)oic acid, 404
— Tiglic acid, 404
$C_5H_8O_4$ Glutaric acid, 404
$C_5H_9F$ Cyclopentyl fluoride, 301
$C_5H_9Cl$ Cyclopentyl chloride, 301
$C_5H_9Br$ Cyclopentyl bromide, 301
$C_5H_9BrO_2$ Ethyl bromopropionate, 514
$C_5H_9I$ Cyclopentyl iodide, 301
$C_5H_9N$ 2-Methylbutyronitrile, 541
— Valeronitrile, 533
— *iso*Valeronitrile, 534
$C_5H_9NO$ Pentene(2)amide, 585, 586, 587
$C_5H_9NO_2$ Proline, 587
$C_5H_{10}$ Cyclopentane, 184
— 2-Methylbutene-1, 127, 628
— 2-Methylbutene-2, 128, 628
— 3-Methylbutene-1, 127
— Pentene-1, 124, 628
— *cis*-Pentene-2, 125
— *trans*-Pentene-2, 126
— *iso*Propylethylene, 127
$C_5H_{10}ClNO_4$ Glutamic acid hydrochloride, 604
$C_5H_{10}Br_2$ 1,5-Dibromopentane, 272
— Pentamethylene dibromide, 272
$C_5H_{10}N_2O_3$ Alanylglycine, 587
$C_5H_{10}O$ Cyclopentanol, 489
— Diethylketone, 357
— Ethylvinylcarbinol, 334
— Methylpropylketone, 362
$C_5H_{10}O_2$ Butyl formate, 411
— 2,2-Dimethylpropionic acid, 392
— Ethyl propionate, 423
— Methyl butyrate, 426
— Methyl *iso*butyrate, 430
— 2-Methylbutyric acid, 392
— 3-Methylbutyric acid, 391
— Methylethylacetic acid, 392
— *iso*Propylacetic acid, 391
— Propyl acetate, 418
— *iso*Propyl acetate, 419
— Trimethylacetic acid, 392
— Valeric acid, 390
— *iso*Valeric acid, 391
$C_5H_{10}O_3$ Ethyl carbonate, 447
$C_5H_{11}F$ Amyl fluoride, 270
— 2-Fluoropentane, 272

$C_5H_{11}Cl$ 2-Chloropentane, 272
$C_5H_{11}Br$ *iso*Amyl bromide, 271
— 2-Bromopentane, 272
$C_5H_{11}I$ 2-Iodopentane, 272
$C_5H_{11}N$ Cyclopentylamine, 567
— Piperidine, 574
$C_5H_{11}NO$ Valeramide, 584, 586, 587
$C_5H_{11}NO_2$ 1-Nitropentane, 578
— 1-Nitro*iso*pentane, 578
$C_5H_{12}$ 2,2-Dimethylpropane, 40
— 2-Methylbutane, 36
— Pentane, 30
— *iso*Pentane, 36
— Tetramethylmethane, 40
$C_5H_{12}N_2O_2$ Ornithine, 587
$C_5H_{12}O$ Amyl alcohol, 325
— *active* Amyl alcohol, 326
— *iso*Amyl alcohol, 327
— *sec.*Amyl alcohol, 328
— *tert.*Amyl alcohol, 328
— *iso*Butylcarbinol, 327
— *sec.*Butylcarbinol, 326
— Diethylcarbinol, 329
— Dimethyl-ethylcarbinol, 328
— 1,1-Dimethylpropanol, 328
— 1-Ethylpropanol, 329
— Ethylpropyl ether, 350
— 1-Methylbutanol, 328
— 2-Methylbutanol, 326
— Methylpropylcarbinol, 328
$C_5H_{12}O_2$ 1,1-Diethoxymethane, 351, 628
— Diethylformal, 351, 628
— Ethylal, 351, 628
$C_5H_{12}S_4$ Tetramethyl orthothiocarbonate, 618
$C_5H_{14}Cl_2N_2O_2$ Ornithine dihydrochloride, 604

## $C_6$

$C_6Cl_4O_2$ Tetrachloroquinone, 515
$C_6Cl_6$ Hexachlorobenzene, 294
$C_6HCl_3O_2$ Trichloroquinone, 515
$C_6HCl_5$ Pentachlorobenzene, 293
$C_6H_2Cl_2O_2$ 2,6-Dichloroquinone, 515
$C_6H_2Cl_4$ 1,2,3,4-Tetrachlorobenzene, 293
— 1,2,3,5-Tetrachlorobenzene, 293
— 1,2,4,5-Tetrachlorobenzene, 293
$C_6H_2Cl_4O_2$ Tetrachloroquinol, 515
$C_6H_3ClN_2O_4$ 4-Chloro-1,2-dinitrobenzene, 609
$C_6H_3ClO_2$ Monochloroquinone, 515
$C_6H_3Cl_3$ 1,2,3-Trichlorobenzene, 293, 294
— 1,2,4-Trichlorobenzene, 293, 294
— 1,3,5-Trichlorobenzene, 293, 294
$C_6H_3Cl_3O_2$ Trichloroquinol, 515
$C_6H_3BrN_2O_4$ 4-Bromo-1,2-dinitrobenzene, 609
$C_6H_3N_2O_5$ 2,4-Dinitrophenol, 599
$C_6H_3N_3O_7$ Picric acid, 600
— 2,4,6-Trinitrophenol, 600
$C_6H_4FNO_2$ *m*-Fluoronitrobenzene, 607
— *p*-Fluoronitrobenzene, 607
$C_6H_4F_2$ *m*-Difluorobenzene, 291
— *p*-Difluorobenzene, 291
$C_6H_4ClNO_2$ *m*-Chloronitrobenzene, 608
— *o*-Chloronitrobenzene, 608
— *p*-Chloronitrobenzene, 608
$C_6H_4Cl_2$ *m*-Dichlorobenzene, 293
— *o*-Dichlorobenzene, 292, 628
— *p*-Dichlorobenzene, 292
$C_6H_4Cl_2O_2$ 2,6-Dichloroquinol, 515
$C_6H_4BrNO_2$ *m*-Bromonitrobenzene, 609
$C_6H_4Br_2$ *p*-Dibromobenzene, 294
$C_6H_4N_2O_4$ *m*-Dinitrobenzene, 593
— *o*-Dinitrobenzene, 593
— *p*-Dinitrobenzene, 593
$C_6H_4N_2O_5$ 2,4-Dinitrophenol, 599
$C_6H_4O_2$ *p*-Benzoquinone, 475
$C_6H_5F$ Fluorobenzene, 281
$C_6H_5FO$ *m*-Fluorophenol, 514
— *o*-Fluorophenol, 514
— *p*-Fluorophenol, 514
$C_6H_5F_2N$ 2,5-Difluoroaniline, 606
$C_6H_5Cl$ Chlorobenzene, 282
$C_6H_5ClO_2$ Monochloroquinol, 515
$C_6H_5Br$ Bromobenzene, 286
$C_6H_5I$ Iodobenzene, 289
$C_6H_5NO_2$ Nitrobenzene, 591
$C_6H_5NO_3$ *o*-Nitrophenol, 598
— *p*-Nitrophenol, 599
$C_6H_5NO_4$ 2-Nitroresorcinol, 600
$C_6H_5N_3$ Diazobenzeneimide, 567
— Phenylazoimide, 567
$C_6H_6$ Benzene, 140, 628
$C_6H_6FN$ *m*-Fluoroaniline, 605
— *o*-Fluoroaniline, 605
— *p*-Fluoroaniline, 605
$C_6H_6ClN$ *o*-Chloroaniline, 607
$C_6H_6Cl_6$ Hexachlorocyclohexanes, 301
$C_6H_6BrN$ *m*-Bromoaniline, 607
— *o*-Bromoaniline, 607
— *p*-Bromoaniline, 607
$C_6H_6N_2O_2$ *p*-Nitroaniline, 601
$C_6H_6O$ Phenol, 459
$C_6H_6OS$ 2-Acetylthiophen, 624
$C_6H_6O_2$ *m*-Dihydroxybenzene, 468
— *o*-Dihydroxybenzene, 467
— *p*-Dihydroxybenzene, 468
— Pyrocatechol, 467
— Quinol, 468
— Resorcinol, 468

$C_6H_6S$ Thiophenol, 621
$C_6H_7N$ Aniline, 551
— 2-Methylpyridine, 570
— α-Picoline, 570
$C_6H_8$ Cyclohexadiene-1,3, 207
$C_6H_8ClN$ Aniline hydrochloride, 605
$C_6H_8N_2$ Phenylhydrazine, 565
$C_6H_8O_4$ Methyl fumarate, 454
— Methyl maleate, 455
$C_6H_9Cl_3O_2$ Ethyl ω-trichlorobutyrate, 514
$C_6H_9N$ Cyclopentylcyanide, 568
— Hexene(5)nitrile, 545
$C_6H_{10}$ Butylacetylene, 140
— Cyclohexene, 205
— Hexyne-1, 140
— 1-Methylcyclopentene, 192
$C_6H_{10}ClN$ α-Chlorocapronitrile, 603
— α-Ethyl-β-chlorobutyronitrile, 603
$C_6H_{10}O$ Cyclohexanone, 493
— Mesityloxide, 365
— *iso*Mesityloxide, 365
— 4-Methylpenten-3-one-2, 365
— 4-Methylpenten-4-one-2, 365
$C_6H_{10}O_2$ Ethyl crotonate, 453
— Trimethylacrylic acid, 404
$C_6H_{10}O_3$ Propionic anhydride, 376
$C_6H_{10}O_4$ Adipic acid, 404
— Ethylene diacetin 444
— Ethylene glycol diacetate, 444
— Ethyl oxalate, 448
— Methylglutaric acid, 404
— Methyl methylmalonate, 452
— Methyl succinate, 450
$C_6H_{10}O_4S_2$ β,β′-Dithiodilactic acid, 621
$C_6H_{10}O_5$ Methyl malate, 453
$C_6H_{10}O_6$ Methyl tartrate, 453
— Methyl *meso*tartrate, 453
$C_6H_{11}ClO$ Caproyl chloride, 510
$C_6H_{11}BrO_2$ Ethyl bromobutyrate, 514
— Ethyl bromo*iso*butyrate, 514
$C_6H_{11}N$ Capronitrile, 535
— *iso*Capronitrile, 536
— 2-Methylvaleronitrile, 541
$C_6H_{11}NO$ Hexene(2)amide, 585, 586, 587
$C_6H_{12}$ Cyclohexane, 193
— 2,3-Dimethylbutene-1, 130
— 2,3-Dimethylbutene-2, 131
— 3,3-Dimethylbutene-1, 130
— Ethylcyclobutane, 183
— Hexene-1, 129
— Methylcyclopentane, 187
— 3-Methylpentene-2, 129
— Tetramethylethylene, 131
$C_6H_{12}N_2O_4S_2$ Cystine, 621
$C_6H_{12}O$ Ethylpropylketone, 364
— Cyclohexanol, 491
— Methylbutylketone, 362
— 1-Methylcyclopentanol-1, 489
— Propylvinylcarbinol, 334
$C_6H_{12}O_2$ Amyl formate, 411
— Butyl acetate, 419
— *sec.*Butyl acetate, 420
— *sec.*Butylacetic acid, 394
— *tert.*Butylacetic acid, 394
— Caproic acid, 392
— *iso*Caproic acid, 393
— Diethylacetic acid, 394
— 2,2-Dimethylbutyric acid, 394
— 2,3-Dimethylbutyric acid, 394
— Dimethylethylacetic acid, 394
— Ethyl butyrate, 428
— Ethyl *iso*butyrate, 432
— 2-Ethylbutyric acid, 394
— Methylpropylacetic acid, 394
— Methyl*iso*propylacetic acid, 394
— Methyl valerate, 435
— 2-Methylvaleric acid, 394
— Propyl propionate, 425
$C_6H_{12}O_3$ Paraldehyde, 500
$C_6H_{12}O_6$ α-Galactose, 504
— Sorbose, 504
$C_6H_{13}F$ 2-Fluorohexane, 272, 628
— Hexyl fluoride, 272
— *sec.*Hexyl fluoride, 272, 628
$C_6H_{13}N$ Cyclohexylamine, 568
$C_6H_{13}NO$ Caproic amide, 584, 586, 587
$C_6H_{13}NO_2$ Leucine, 587
$C_6H_{13}N_3O_3$ Citrulline, 587
$C_6H_{14}$ Bi*iso*propyl, 52
— 2,2-Dimethylbutane, 56
— 2,3-Dimethylbutane, 52, 628
— Hexane, 41
— 2-Methylpentane, 47, 628
— 3-Methylpentane, 50
— Trimethylethylmethane, 56
$C_6H_{14}N_4O_2$ Arginine, 587
$C_6H_{14}O$ 2,3-Dimethylbutanol-2, 331
— Dipropyl ether, 346
— Di*iso*propyl ether, 347, 628
— Hexyl alcohol, 330
— Hexylic alcohols, 331
— 3-Methylpentanol-3, 331
$C_6H_{14}O_2$ 1,1-Diethoxyethane, 628
— Diethylacetal, 628
$C_6H_{14}O_3S$ Dipropyl sulphite, 621
$C_6H_{14}O_4S$ Dipropyl sulphate, 621
$C_6H_{14}O_6$ Mannitol, 338
$C_6H_{15}N$ Dipropylamine, 524

$C_6H_{15}N$ Hexylamine, 524
— Triethylamine, 523
$C_6H_{15}O_3B$ Triethyl borate, 627
$C_6H_{15}O_4P$ Triethyl orthophosphate, 625
$C_6H_{15}P$ Triethylphosphine, 625

## $C_7$

$C_7F_{14}$ Perfluoromethylcyclohexane, 301
— Perfluorodimethylcyclopentane, 301
— Perfluoroethylcyclopentane, 301
$C_7F_{16}$ Heptyl perfluoride, 273
— Perfluoroheptane, 273
$C_7H_4Cl_2O$ *m*-Chlorobenzoyl chloride, 516
— *o*-Chlorobenzoyl chloride, 516
— *p*-Chlorobenzoyl chloride, 516
$C_7H_5F_3$ Benzotrifluoride, 295
— Phenylfluoroform, 295
— Phenyltrifluoromethane, 295
$C_7H_5ClO$ Benzoyl chloride, 516
$C_7H_5ClO_2$ *m*-Chlorobenzoic acid, 515
— *o*-Chlorobenzoic acid, 515
— *p*-Chlorobenzoic acid, 515
$C_7H_5Cl_3$ Benzotrichloride, 296
— Phenylchloroform, 296
— Phenyltrichloromethane, 296
$C_7H_5N$ Benzonitrile, 566
$C_7H_5NO_4$ *m*-Nitrobenzoic acid, 601
— *p*-Nitrobenzoic acid, 601
$C_7H_5N_3O_6$ 2,4,6-Trinitrotoluene, 597
$C_7H_6N_2O_5$ Dinitro-*o*-cresols, 600
$C_7H_6O$ Benzaldehyde, 474
$C_7H_6O_2$ Benzoic acid, 480
$C_7H_6O_3$ Gallic acid, 482
— *o*-Hydroxybenzoic acid, 481
— Salicylic acid, 481
$C_7H_7F$ *m*-Fluorotoluene, 294
— *o*-Fluorotoluene, 294
— *p*-Fluorotoluene, 294
$C_7H_7Cl$ Benzyl chloride, 295
— *m*-Chlorotoluene, 297
— *o*-Chlorotoluene, 297
— *p*-Chlorotoluene, 297
$C_7H_7Br$ *m*-Bromotoluene, 297
— *o*-Bromotoluene, 297, 298
— *p*-Bromotoluene, 297, 299
$C_7H_7NO$ Benzamide, 589
— Formanilide, 589
$C_7H_7NO_2$ *m*-Aminobenzoic acid, 589
— *o*-Aminobenzoic acid, 589
— *p*-Aminobenzoic acid, 589
— Anthranilic acid, 589
— *m*-Nitrotoluene, 595
— *o*-Nitrotoluene, 594
— *p*-Nitrotoluene, 596
$C_7H_7NO_2$ Salicylamide, 589
$C_7H_7NO_3$ *p*-Nitroanisole, 601
$C_7H_8$ Toluene, 150, 628
$C_7H_8N_2O$ *p*-Nitrosomethylaniline, 597
— Phenylmethylnitrosamine, 597
$C_7H_8O$ Anisole, 469
— Benzyl alcohol, 457
— *m*-Cresol, 464
— *o*-Cresol, 462
— *p*-Cresol, 465
$C_7H_8O_2$ *m*-Methoxyphenol, 472
— *o*-Methoxyphenol, 472
— *p*-Methoxyphenol, 472
$C_7H_9N$ Methylaniline, 554
— *m*-Toluidine, 560
— *o*-Toluidine, 558
— *p*-Toluidine, 561
$C_7H_{10}N_2$ 1-Methyl-2-phenylhydrazine, 565
— Pentamethylene dicyanide, 550
— Pimelonitrile, 550
$C_7H_{10}O_4$ Methyl citraconate, 456
— Methylcyclopropane-1,1-dicarboxylate, 498
— Methyl mesaconate, 456
$C_7H_{11}F_3$ Cyclohexylfluoroform, 301
— Cyclohexyltrifluoromethane, 301
— Trifluoromethylcyclohexane, 301
$C_7H_{11}N$ Cyclohexylcyanide, 568
— Heptene(6)nitrile, 546
$C_7H_{12}$ 1,2-Dimethylcyclopentene, 192
— 1,5-Diméthylcyclopentene, 192
— Heptyne-1, 140
$C_7H_{12}ClN$ α-Chloroheptanenitrile, 603
— α-Chlorooenanthonitrile, 603
$C_7H_{12}O$ 2-Methylcyclohexanone, 494
— 3-Methylcyclohexanone, 494
— 4-Methylcyclohexanone, 494
$C_7H_{12}O_2$ Hepten(6)oic acid, 404
— Propyl crotonate, 453
— *iso*Propyl crotonate, 453
$C_7H_{12}O_4$ Dimethylglutaric acid, 404
— Ethyl malonate, 449
— Methyl dimethylmalonate, 452
— Methyl ethylmalonate, 452
— Pimelic acid, 404
$C_7H_{13}ClO$ Heptanoyl chloride, 511
— Oenanthoyl chloride, 511
$C_7H_{13}N$ Heptanenitrile, 536
— 2-Methylcapronitrile, 541
— Oenanthonitrile, 536
$C_7H_{13}NO$ Heptene(2)amide, 585, 586, 587
$C_7H_{14}$ 1,1-Dimethylcyclopentane, 191
— 1,2-Dimethylcyclopentane, 191
— Ethylcyclopentane, 189, 628

$C_7H_{14}$ 3-Ethylpentene-2, 134
— Heptene-1, 132
— Methylcyclohexane, 197
— 2,3,3-Trimethylbutene-1, 133
$C_7H_{14}O$ Butylvinylcarbinol, 334
— Dimethylcyclopentanol, 490
— Dipropylketone, 358
— Ethylbutylketone, 364
— Heptyl aldehyde, 353
— Methylamylketone, 364
— Oenanthal, 353
$C_7H_{14}O_2$ Amyl acetate, 419
— Butyl propionate, 425
— *sec.*Butyl propionate, 426
— Ethyl trimethylacetate, 435
— Ethyl valerate, 435
— Heptanoic acid, 395
— Hexyl formate, 412
— Methyl caproate, 435
— Oenanthic acid, 395
— Propyl butyrate, 429
— Propyl *iso*butyrate, 433
— *iso*Propyl butyrate, 429
— *iso*Propyl *iso*butyrate, 433
— *iso*Butyl propionate, 425
$C_7H_{14}O_3$ *iso*Butyl lactate, 452
— *sec.*Butyl lactate, 452
— *tert.*Butyl lactate, 452
$C_7H_{15}F$ Heptyl fluoride, 273
$C_7H_{15}Cl$ 2-Chloroheptane, 273
— 3-Chloroheptane, 273
— 4-Chloroheptane, 273
— Heptyl chloride, 273
$C_7H_{15}Br$ 2-Bromoheptane, 273
— 3-Bromoheptane, 273
— 4-Bromoheptane, 273
— Heptyl bromide, 274
$C_7H_{15}I$ Heptyl iodide, 274
$C_7H_{15}NO$ Oenanthamide, 584, 586, 587
$C_7H_{16}$ Dimethyldiethylmethane, 78
— 2,2-Dimethylpentane, 72
— 2,3-Dimethylpentane, 74
— 2,4-Dimethylpentane, 76
— 3,3-Dimethylpentane, 78
— Di*iso*propylmethane, 76
— 3-Ethylpentane, 70
— Heptane, 60, 628
— Methylethyl*iso*propylmethane, 74
— 2-Methylhexane, 66
— 3-Methylhexane, 68
— Triethylmethane, 70
— 2,2,3-Trimethylbutane, 80
— Trimethyl-*iso*-propylmethane, 80
$C_7H_{16}O$ Heptyl alcohol, 331
$C_7H_{17}N$ Heptylamine, 524

## $C_8$

$C_8F_{16}$ Perfluoro-*m*-dimethylcyclohexane, 301
— Perfluoro-*o*-dimethylcyclohexane, 301
— Perfluoro-*p*-dimethylcyclohexane, 301
$C_8H_6ClNO_3$ *m*-Nitrochloroacetophenone, 609
— *o*-Nitrochloroacetophenone, 609
$C_8H_6BrN$ Bromobenzylcyanide, 604
$C_8H_6N_2$ Quinoxaline, 574
$C_8H_6O_4$ Phthalic acid, 482
— Terephthalic acid, 482
$C_8H_7ClO$ Chloroacetophenone, 515
$C_8H_8$ Cyclooctatetraene, 207
$C_8H_8O$ Acetophenone, 475
$C_8H_8O_2$ Methyl benzoate, 482
— *p*-Xyloquinone, 475
$C_8H_8O_3$ Methyl salicylate, 487
$C_8H_9FO$ *m*-Fluorophenetole, 514
— *o*-Fluorophenetole, 514
— *p*-Fluorophenetole, 514
$C_8H_9NO$ Acetanilide, 589
— Phenylacetamide, 589
$C_8H_9NO_2$ Hydroxyacetanilide, 589
$C_8H_{10}$ Ethylbenzene, 154
— *m*-Xylene, 164
— *o*-Xylene, 161
— *p*-Xylene, 166
$C_8H_{10}N_4O_7$ Ethylammonium picrate, 597
$C_8H_{10}O$ Phenetole, 470
$C_8H_{10}O_2$ Creosol, 472
— *m*-Dimethoxybenzene, 472
— *o*-Dimethoxybenzene, 471
— *p*-Dimethoxybenzene, 472
— 2-Methoxy-4-methylphenol, 472
— Veratrole, 471
— *p*-Xyloquinol, 469
$C_8H_{11}N$ Dimethylaniline, 555
— Ethylaniline, 556
— *m*-Xylidine, 563
$C_8H_{12}Cl_2O_4$ Ethyl dichlorosuccinate, 514
$C_8H_{12}O_4$ Ethyl fumarate, 455
$C_8H_{13}N$ Octene(7)nitrile, 546
$C_8H_{14}$ 1,4-Dimethylcyclohexene, 207
$C_8H_{14}ClN$ α-Chlorocaprylonitrile, 603
— α-Chlorooctanenitrile, 603
$C_8H_{14}O_2$ Butyl crotonate, 453
— *iso*Butyl crotonate, 453
— *sec.*Butyl crotonate, 453
— 2-Ethyl-3-propylacrylic acid, 404
— 2-Methyl-3-ethylpenten(3)oic acid, 404
— 3-Propyl-2-ethylacrylic acid, 404
$C_8H_{14}O_4$ Ethyl succinate, 450

$C_8H_{14}O_4$ Methyl methylethylmalonate, 452
— Methyl propylmalonate, 452
— Suberic acid, 404
$C_8H_{14}O_5$ Ethyl malate, 453
$C_8H_{14}O_6$ Ethyl tartrate, 453
— Ethyl *meso*tartrate, 453
$C_8H_{15}ClO$ Capryloyl chloride, 511
— Octoyl chloride, 511
$C_8H_{15}N$ Caprylonitrile, 537
— 2-Methylheptanenitrile, 542
— 2-Methyloenanthonitrile, 542
— Octanenitrile, 537
$C_8H_{15}NO$ Octene(2)amide, 585, 586, 587
$C_8H_{16}$ 1,1-Dimethylcyclohexane, 201
— 1,2-Dimethylcyclohexane, 201
— 1,3-Dimethylcyclohexane, 204
— 1,4-Dimethylcyclohexane, 204
— Ethylcyclohexane, 201
— 6-Methylheptene-1, 134
— Propylcyclopentane, 190
$C_8H_{16}N_2O_3$ Leucylglycine, 587
$C_8H_{16}O$ 1,2-Dimethylcyclohexanol-1, 492
— 1,3-Dimethylcyclohexanol-1, 492
— 1,4-Dimethylcyclohexanol-1, 492
— Ethylamylketone, 364
— Methylhexylketone, 362
— Propylbutylketone, 364
— 2,2,4-Trimethylpentanone-3, 365
$C_8H_{16}O_2$ Amyl propionate, 425
— *sec.*Amyl propionate, 426
— Butyl butyrate, 429
— *iso*Butyl butyrate, 429
— *iso*Butyl *iso*butyrate, 433
— *sec.*Butyl butyrate, 430
— Caprylic acid, 396
— Ethyl caproate, 436
— Heptyl formate, 412
— Hexyl acetate, 420
— *sec.*Hexyl acetate, 420
— Methyl oenanthate, 439
— Propyl valerate, 435
$C_8H_{17}F$ Octyl fluoride, 275
$C_8H_{17}Cl$ 2-Chloro-2,3,3-trimethylpentane, 275
$C_8H_{17}Br$ Octyl bromide, 275
$C_8H_{17}I$ Octyl iodide, 275
$C_8H_{17}NO$ Caprylamide, 584, 586, 587
$C_8H_{18}$ Bi*iso*butyl, 89
— 2,3-Dimethylhexane, 89
— 2,4-Dimethylhexane, 89
— 2,5-Dimethylhexane, 89
— 3,3-Dimethylhexane, 89
— 3,4-Dimethylhexane, 89
— 3-Ethylhexane, 89
— Hexamethylethane, 96, 628
$C_8H_{18}$ 2-Methyl-3-ethylpentane, 95
— 2-Methylheptane, 89
— 3-Methylheptane, 88
— 4-Methylheptane, 89
— Octane, 83
— "*iso*Octane", see 2,2,4-Trimethylpentane
— 2,2,3,3-Tetramethylbutane, 96, 628
— 2,2,3-Trimethylpentane, 91
— 2,2,4-Trimethylpentane, 91
— 2,3,3-Trimethylpentane, 95
— 2,3,4-Trimethylpentane, 95
$C_8H_{18}O$ Dibutyl ether, 347
— Methylhexylcarbinol, 331
— Octyl alcohol, 331
— Octyl alcohols, 331
— *sec.*Octyl alcohol, 331
— *tert.*Octyl alcohol, 332
$C_8H_{18}O_3S$ Dibutyl sulphite, 621
$C_8H_{18}O_4S$ Dibutyl sulphate, 621
$C_8H_{19}N$ Dibutylamine, 524
— Octylamine, 524
$C_8H_{20}O_4Si$ Ethyl orthosilicate, 626

## $C_9$

$C_9F_{16}$ Perfluorohexahydroindane, 301
$C_9F_{18}$ Perfluoro-1,3,5-trimethylcyclohexane, 301
$C_9H_7N$ Quinoline, 572
— *iso*Quinoline, 571
$C_9H_9NO_3$ Hippuric acid, 587
$C_9H_{10}O_2$ *m*-Cresyl acetate, 482
— Ethyl benzoate, 484
$C_9H_{10}O_3$ Methyl mandelate, 486
— Methyl phenylglycolate, 486
$C_9H_{11}N$ Tetrahydroquinoline, 574
$C_9H_{11}NO$ Methylacetanilide, 589
$C_9H_{11}NO_2$ Ethyl carbanilate, 589
— N-Phenylurethan, 589
$C_9H_{11}NO_3$ Tyrosine, 587
$C_9H_{12}$ *pseudo*Cumene, 170, 628
— Hemimellitene, 171, 628
— Mesitylene, 170
— Propylbenzene, 157
— *iso*Propylbenzene, 158
— 1,2,3-Trimethylbenzene, 171, 628
— 1,2,4-Trimethylbenzene, 170, 628
— 1,3,5-Trimethylbenzene, 170
$C_9H_{12}O$ Phenylethylcarbinol, 458
— Phenylpropyl ether, 471
$C_9H_{12}O_2$ 4-Propylpyrocatechol, 469
$C_9H_{13}N$ Dimethyl-*o*-toluidine, 563
— Dimethyl-*p*-toluidine, 563
$C_9H_{14}O_3$ Methylcyclopentanone ethyl carboxylate, 490

$C_9H_{16}ClN$ α-Chlorononanenitrile, 603
— α-Chloropelargonitrile, 603
$C_9H_{16}O_2$ *iso*Amyl crotonate, 453
$C_9H_{16}O_4$ Azelaic acid, 404
— Ethyl glutarate, 451
— Methyl methylpropylmalonate, 452
— Methyl pimelate, 452
— Propyl malonate, 452
$C_9H_{17}ClO$ Nonoyl chloride, 511
— Pelargoyl chloride, 511
$C_9H_{17}N$ 2-Methylcaprylonitrile, 542
— 2-Methyloctanenitrile, 542
— Nonanenitrile, 538
— Pelargonitrile, 538
$C_9H_{17}NO$ Nonene(2)amide, 585, 586, 587
$C_9H_{18}$ Butylcyclopentane, 190
— *iso*Propylcyclohexane, 200
$C_9H_{18}O$ Dibutylketone, 358
— Di*iso*butylketone, 359
— Diethylcyclopentanol, 490
— Methylheptylketone, 362
— Methylpropylcyclopentanol, 490
— 2,2,4,4-Tetramethylpentanone-3, 365
$C_9H_{18}O_2$ Amyl *iso*butyrate, 433
— *sec.*Amyl butyrate, 430
— *sec.*Butyl valerate, 435
— Ethyl oenanthate, 438
— Heptyl acetate, 420
— *sec.*Heptyl acetate, 420
— Hexyl propionate, 426
— *sec.*Hexyl propionate, 426
— Methyl caprylate, 442
— Nonoic acid, 397
— Octyl formate, 412
— *sec.*β-Octyl formate, 412
— Pelargonic acid, 397
— Propyl caproate, 436
$C_9H_{19}NO$ Pelargonamide, 584, 587
$C_9H_{20}$ 3,3-Diethylpentane, 101
— 2,2-Dimethyl-3-ethylpentane, 101
— 2,4-Dimethyl-3-ethylpentane, 101
— 2,5-Dimethylheptane, 99
— 2,6-Dimethylheptane, 100
— 2-Methyloctane, 99
— 3-Methyloctane, 99
— 4-Methyloctane, 99
— Nonane, 97, 628
— Tetraethylmethane, 101
— 2,2,3,3-Tetramethylpentane, 102
— 2,2,3,4-Tetramethylpentane, 102
— 2,2,4,4-Tetramethylpentane, 102
— 2,3,3,4-Tetramethylpentane, 102
— 2,2,4-Trimethylhexane, 101
— 2,2,5-Trimethylhexane, 101
$C_9H_{20}$ 2,3,5-Trimethylhexane, 101
$C_9H_{20}O$ Di*iso*butylcarbinol, 332
Methyloctanols, 332
— Methyl *sec.*octyl ether, 350
— Nonyl alcohols, 332
— *tert.*Nonyl alcohol, 332
$C_9H_{21}N$ Nonylamine, 524
$C_9H_{21}O_4P$ Tripropyl orthophosphate, 625

## $C_{10}$

$C_{10}H_5N_3O_6$ 1,3,8-Trinitronaphthalene, 597
— 1,4,5-Trinitronaphthalene, 597
$C_{10}H_6N_2O_4$ 1,5-Dinitronaphthalene, 597
— 1,8-Dinitronaphthalene, 597
$C_{10}H_7Br$ α-Bromonaphthalene, 300
$C_{10}H_7NO_2$ α-Nitronaphthalene, 597
$C_{10}H_8$ Naphthalene, 177
$C_{10}H_9N$ 2-Methylquinoline, 574
— Quinaldine, 574
$C_{10}H_{10}O$ Benzylideneacetone, 479
$C_{10}H_{10}O_2$ Benzoylacetone, 479
— Safrole, 473
— *iso*Safrole, 473
$C_{10}H_{11}ClO_2$ Ethyl phenylchloroacetate, 516
$C_{10}H_{12}$ 1,2,3,4-Tetrahydronaphthalene, 208
— Tetralin, 208
$C_{10}H_{12}O$ Anethole, 471
— *p*-Propenylanisole, 471
$C_{10}H_{12}O_2$ Eugenol, 472
$C_{10}H_{12}O_3$ Ethyl mandelate, 486
— Ethyl *o*-methoxybenzoate, 488
— Ethyl methylsalicylate, 488
— Ethyl phenylglycolate, 486
$C_{10}H_{13}NO$ Ethylacetanilide, 589
$C_{10}H_{14}$ Butylbenzene, 159
— *iso*Butylbenzene, 160
— *sec.*Butylbenzene, 160
— *tert.*Butylbenzene, 160
— Diethylbenzenes, 173
— 1,3-Dimethyl-4-ethylbenzene, 173
— 1,3-Dimethyl-5-ethylbenzene, 173
— Durene, 172
— *iso*Durene, 172
— 1-Methyl-2-*iso*propylbenzene, 173
— 1-Methyl-3-*iso*propylbenzene, 173
— Prehnitene, 172
— 1,2,3,4-Tetramethylbenzene, 172
— 1,2,3,5-Tetramethylbenzene, 172
— 1,2,4,5-Tetramethylbenzene, 172
$C_{10}H_{14}N_2$ Anabasine, 576
— Nicotine, 575
$C_{10}H_{14}N_4O_7$ *iso*Butylammonium picrate, 597
— Diethylammonium picrate, 597
$C_{10}H_{14}O$ Carvacrol, 466

$C_{10}H_{14}O$ Carvone, 498
— 2-Methyl-5-*iso*propylphenol, 466
— 3-Methyl-4-*iso*propylphenol, 467
— 5-Methyl-2-*iso*propylphenol, 466
— Phenylbutyl ether, 471
— Phenylpropylcarbinol, 458
— Thymol, 466
— *p*-Thymol, 467
$C_{10}H_{15}N$ Diethylaniline, 557
$C_{10}H_{16}$ α-Pinene, 209
— β-Pinene, 209
$C_{10}H_{16}O$ Camphor, 497
— Carvenone, 498
— Dihydrocarvone, 498
— Dihydroeucarvone, 498
— Pulegone, 498
$C_{10}H_{18}$ Decahydronaphthalene, 209
— Decalin, 209
$C_{10}H_{18}ClN$ α-Chlorodecanenitrile, 603
$C_{10}H_{18}O$ Borneol, 497
— Fenchyl alcohol, 496
— Terpineol, 496
$C_{10}H_{18}O_4$ Ethyl adipate, 452
— Ethyl dimethylsuccinate, 452
— Methyl ethylpropylmalonate, 452
— Methyl suberate, 452
— Propyl succinate, 451
— Sebacic acid, 404
$C_{10}H_{19}ClO$ Caprinoyl chloride, 511
— Decanoyl chloride, 511
$C_{10}H_{19}ClO_2$ β-Octyl chloroacetate, 513
$C_{10}H_{19}BrO_2$ Ethyl bromodipropylacetate, 514
— β-Octyl bromoacetate, 513
$C_{10}H_{19}IO_2$ β-Octyl iodoacetate, 513
$C_{10}H_{19}N$ Decanenitrile, 539
— 2-Methylnonanenitrile, 542
— 2-Methylpelargonitrile, 542
$C_{10}H_{19}NO$ Decene(2)amide, 585, 587
$C_{10}H_{20}O$ Butylamylketone, 364
— Menthol, 495
— Methyloctylketone, 362
$C_{10}H_{20}O_2$ *sec.*Amyl valerate, 435
— Butyl caproate, 436
— *sec.*Butyl caproate, 437
— Capric acid, 397
— Ethyl caprylate, 440
— Heptyl propionate, 426
— *sec.*Heptyl propionate, 426
— Hexyl butyrate, 430
— *sec.*Hexyl butyrate, 430
— Methyl pelargonate, 442
— *sec.*γ-Nonyl formate, 412
— Octyl acetate, 420
— *sec.*Octyl acetate, 420
$C_{10}H_{20}O_2$ Propyl oenanthate, 439
$C_{10}H_{21}NO$ Decaneamide, 584, 587
$C_{10}H_{22}$ Bi*iso*amyl, 105
— Decane, 103
— 2,7-Dimethyloctane, 105
— 2,4-Dimethyl-3-*iso*propylpentane, 107
— 2-Methylnonane, 106
— 3-Methylnonane, 106
— 4-Methylnonane, 106
— 5-Methylnonane, 106
— 2,2,3,3,4-Pentamethylpentane, 107
— 2,2,3,4,4-Pentamethylpentane, 107
— 2,2,3,3-Tetramethylhexane, 107
— 2,2,4,5-Tetramethylhexane, 107
— 2,2,5,5-Tetramethylhexane, 107
$C_{10}H_{22}O$ Decyl alcohols, 332
— *tert.* Decyl alcohol, 332
— Diamyl ether, 348
— Ethyl-*sec.*octyl ether, 350
$C_{10}H_{22}O_2$ 1,1-Dibutoxyethane, 352
— Dibutyl acetal, 352
$C_{10}H_{22}O_3S$ Diamyl sulphite, 621
$C_{10}H_{22}O_4S$ Diamyl sulphate, 621
$C_{10}H_{23}N$ Decylamine, 524

## $C_{11}$

$C_{11}H_{10}$ 1-Methylnaphthalene, 180
— 2-Methylnaphthalene, 180
$C_{11}H_{11}NO_6$ Methyl *o*-nitrobenzoyloxypropionate, 601
$C_{11}H_{12}N_2O$ Antipyrine, 589
— Phenazone, 589
$C_{11}H_{12}N_2O_4$ Hippurylglycine, 587
$C_{11}H_{12}O$ Styrylethylketone, 479
$C_{11}H_{12}O_2$ Ethyl cinnamate, 485
— 5-Phenylpenten(3)oic acid, 481
$C_{11}H_{13}ClO_2$ Propyl phenylchloroacetate, 516
$C_{11}H_{14}$ 5-Methyl-1,2,3,4-tetrahydronaphthalene, 208
— 6-Methyl-1,2,3,4-tetrahydronaphthalene, 208
$C_{11}H_{14}O$ Butyl phenylketone, 478
$C_{11}H_{14}O_2$ *iso*Butyl benzoate, 485
— *sec.*Butyl benzoate, 485
— *m*-Butylbenzoic acid, 481
— *o*-Butylbenzoic acid, 481
— *p*-Butylbenzoic acid, 481
— Methylbenzylcarbinyl acetate, 482
— Methyleugenol, 473
— Methyl*iso*eugenol, 473
— *iso*Propenylresorcinol dimethylether, 473
$C_{11}H_{14}O_3$ Propyl mandelate, 486
— Propyl phenylglycolate, 486

$C_{11}H_{16}$ Amylbenzene, 161
— *m-tert.*Butyltoluene, 173
— *o-tert.*Butyltoluene, 173
— *p-tert.*Butyltoluene, 173
— Pentamethylbenzene, 172
$C_{11}H_{16}O$ 3-Methyl-4-*iso*propyl-1-methoxybenzene, 471
— *p*-Thymol methyl ether, 471
$C_{11}H_{16}O_2$ Hydroxythymol methyl ether, 471
— Hydroxy-*p*-thymol methyl ether, 471
— *iso*Propylresorcinol dimethylether, 473
$C_{11}H_{20}$ Undecyne-1, 140
$C_{11}H_{20}ClN$ α-Chloroundecanenitrile, 603
$C_{11}H_{20}O_2$ Undecen(10)oic acid, 404
$C_{11}H_{20}O_4$ Ethyl pimelate, 452
— Methyl azelate, 452
— Methyl dipropylmalonate, 452
— Nonane dicarboxylic acid, 404
— Propyl glutarate, 452
$C_{11}H_{21}N$ 2-Methyldecanenitrile, 542
— Undecanenitrile, 540
$C_{11}H_{21}NO$ Undecene(2)amide, 585, 587
$C_{11}H_{22}O$ Diamylketone, 360
— Methylnonylketone, 362
$C_{11}H_{22}O_2$ Amyl caproate, 436
— Butyl oenanthate, 439
— *sec.*Butyl oenanthate, 440
— Ethyl pelargonate, 443
— Heptyl butyrate, 430
— *sec.*Heptyl butyrate, 430
— Hexyl valerate, 434
— *sec.*Hexyl valerate, 435
— Nonyl acetate, 420
— *sec.*Nonyl acetate, 420
— Octyl propionate, 426
— *sec.*Octyl propionate, 426
— Propyl caprylate, 441
— Undecanoic acid, 398
$C_{11}H_{22}O_3$ *sec.*Octyl methoxyacetate, 453
$C_{11}H_{23}NO$ Undecaneamide, 584, 587
$C_{11}H_{24}$ Undecane, 107
$C_{11}H_{24}O$ Propyl-*sec.*octyl ether, 350
— *tert.*Undecyl alcohol, 332
$C_{11}H_{25}N$ Undecylamine, 524

## $C_{12}$

$C_{12}H_9N$ Carbazole, 574
$C_{12}H_{10}$ Biphenyl, 174
$C_{12}H_{10}O$ Diphenyl ether, 473
$C_{12}H_{10}Se$ Diphenylselenide, 625
$C_{12}H_{11}N$ Diphenylamine, 563
$C_{12}H_{12}$ 1-Ethylnaphthalene, 180
— 2-Ethylnaphthalene, 180
$C_{12}H_{12}O$ Methylnaphthylcarbinol, 458
$C_{12}H_{12}O_2$ Methyl *allo*cinnamyl acrylate, 485
— Methyl 4-phenylbutadiene-1,3-carboxylate-1, 485
$C_{12}H_{14}O_2$ 1,2,3,4-Tetrahydro-2-naphthylacetate, 498
$C_{12}H_{15}ClO_2$ Butyl phenylchloroacetate, 516
$C_{12}H_{15}O_4$ Diethyl phthalate, 486
$C_{12}H_{16}O$ Amyl phenylketone, 478
$C_{12}H_{16}O_2$ Ethyleugenol, 473
— Methylbenzylcarbinyl propionate, 482
$C_{12}H_{18}$ *m*-Di*iso*propylbenzene, 173
— *o*-Di*iso*propylbenzene, 173
— *p*-Di*iso*propylbenzene, 173
— Hexamethylbenzene, 173
— Hexylbenzene, 161
$C_{12}H_{18}N_4O_7$ Triethylammonium picrate, 597
$C_{12}H_{18}O$ 3-Methyl-4-*iso*propyl-1-ethoxybenzene, 471
— *p*-Thymol ethyl ether, 471
$C_{12}H_{18}O_2$ Methoxymethylenecamphor, 498
$C_{12}H_{22}O_3$ Caproic anhydride, 376
$C_{12}H_{22}O_4$ Amyl oxalate, 452
— Decane dicarboxylic acid, 404
— Ethyl suberate, 452
$C_{12}H_{22}O_{11}$ β-Lactose, 505
— Saccharose, 504
$C_{12}H_{23}N$ Dicyclohexylamine, 568
— Dodecanenitrile, 540
— Lauronitrile, 540
— 2-Methylundecanenitrile, 542
$C_{12}H_{24}O$ Methyldecylketone, 362
$C_{12}H_{24}O_2$ Amyl oenanthate, 439
— Butyl caprylate, 441
— *sec.*Butyl caprylate, 442
— Decyl acetate, 420
— *sec.*Decyl acetate, 420
— Ethyl caprate, 443
— Ethyl decoate, 443
— Heptyl valerate, 434
— *sec.*Heptyl valerate, 435
— Hexyl caproate, 436
— *sec.*Hexyl caproate, 437
— Lauric acid, 398
— Octyl butyrate, 430
— *sec.*Octyl butyrate, 430
— Propyl pelargonate, 442
$C_{12}H_{24}O_{12}$ α-Lactose monohydrate, 505
— β-Maltose monohydrate, 505
$C_{12}H_{25}NO$ Dodecaneamide, 584
$C_{12}H_{26}$ Dodecane, 109
$C_{12}H_{26}O$ Butyl-*sec.*octyl ether, 350
— *tert.*Dodecyl alcohol, 332
$C_{12}H_{27}N$ Dodecylamine, 524
— Tributylamine, 524

$C_{12}H_{27}O_4P$ Tributyl orthophosphate, 625

$C_{13}$

$C_{13}H_{10}NAs$ Diphenylcyanoarsine, 625
$C_{13}H_{10}O$ Benzophenone, 478
$C_{13}H_{10}O_3$ Phenyl salicylate, 487
— Salol, 488
$C_{13}H_{12}$ Diphenylmethane, 174
$C_{13}H_{14}$ 1-*iso*Propylnaphthalene, 180
— 2-*iso*Propylnaphthalene, 180
$C_{13}H_{14}O$ Ethylnaphthylcarbinol, 458
$C_{13}H_{14}O_7$ Dimethyl monobenzoyltartrate, 488
$C_{13}H_{16}O$ Benzylidenepinacoline, 479
$C_{13}H_{16}O_2$ 1,2,3,4-Tetrahydro-2-naphthylpropionate, 498
$C_{13}H_{18}O$ Hexylphenylketone, 478
$C_{13}H_{18}O_2$ *sec.*Hexyl benzoate, 485
— Methylbenzylcarbinyl butyrate, 482
$C_{13}H_{20}O$ 3-Methyl-4,6-di*iso*propylphenol, 467
— *p*-*iso*Propylhymol, 467
$C_{13}H_{24}O_4$ Amyl malonate, 452
— Butyl glutarate, 452
— Ethyl azelate, 452
— Propyl pimelate, 452
— Undecane dicarboxylic acid, 404
$C_{13}H_{25}N$ 2-Methyldodecanenitrile, 542
— 2-Methyllauronitrile, 542
— Tridecanenitrile, 540
$C_{13}H_{26}O$ Dihexylketone, 360
— Methylundecylketone, 362
$C_{13}H_{26}O_2$ Amyl caprylate, 441
— Butyl nonoate, 442
— Butyl pelargonate, 442
— *sec.*Butyl nonoate, 443
— *sec.*Butyl pelargonate, 443
— Ethyl undecoate, 443
— Heptyl caproate, 437
— *sec.*Heptyl caproate, 437
— Hexyl oenanthate, 440
— *sec.*Hexyl oenanthate, 440
— Octyl valerate, 434
— *sec.*Octyl valerate, 435
— Tridecanoic acid, 399
— Undecyl acetate, 420
— *sec.*Undecyl acetate, 420
$C_{13}H_{28}$ Tridecane, 110
$C_{13}H_{28}O$ Amyl-*sec.*octyl ether, 350
— *tert.*Tridecyl alcohol, 332
$C_{13}H_{29}N$ Tridecylamine, 524

$C_{14}$

$C_{14}H_8O_4$ Quinizarin, 479
$C_{14}H_9Cl_5$ 1,1-Di-*p*-chlorophenyl-2,2,2-trichloroethane, 299
$C_{14}H_{10}$ Anthracene, 181
— 1,2-Diphenylacetylene, 177
— Phenanthrene, 182
$C_{14}H_{12}$ 1,2-Diphenylethylene, 176
— Stilbene, 176
$C_{14}H_{14}$ Bibenzyl, 176
— 1,1-Diphenylethane, 176
— 1,2-Diphenylethane, 176
$C_{14}H_{14}N_2O_3$ *p*-Azoxyanisole, 590
$C_{14}H_{14}O$ Phenylbenzylcarbinol, 458
$C_{14}H_{14}O_2$ Naphthylmethylcarbinyl acetate, 482
$C_{14}H_{15}N$ Dibenzylamine, 565
$C_{14}H_{20}O_2$ Methylbenzylcarbinyl valerate, 482
$C_{14}H_{22}$ Tetraethylbenzenes, 173
$C_{14}H_{22}N_4O_7$ Dimethyldipropylammonium picrate, 597
$C_{14}H_{27}N$ Myristonitrile, 541
— Tetradecanenitrile, 541
$C_{14}H_{28}O_2$ Amyl nonoate, 442
— Amyl pelargonate, 442
— *sec.*Amyl nonoate, 443
— *sec.*Amyl pelargonate, 443
— Dodecyl acetate, 420
— Ethyl laurate, 443
— Heptyl oenanthate, 440
— *sec.*Heptyl oenanthate, 440
— Hexyl caprylate, 442
— Myristic acid, 399
— Octyl caproate, 437
— *sec.*Octyl caproate, 437
— *sec.*Undecyl propionate, 426
$C_{14}H_{30}$ Tetradecane, 111
$C_{14}H_{30}O$ Hexyl-*sec.*-octyl ether, 350
— *tert.*Tetradecyl alcohol, 332
$C_{14}H_{31}N$ Tetradecylamine, 524

$C_{15}$

$C_{15}H_{16}O_2$ *sec.*Butyl naphthoate, 486
$C_{15}H_{18}O_7$ Diethyl monobenzoyltartrate, 488
$C_{15}H_{20}O_2$ 1,2,3,4-Tetrahydro-2-naphthylvalerate, 498
$C_{15}H_{21}ClO_2$ Octyl chlorobenzoate, 516
$C_{15}H_{21}BrO_2$ Octyl bromobenzoate, 516
$C_{15}H_{21}IO_2$ Octyl iodobenzoate, 516
$C_{15}H_{21}NO_4$ *sec.*Octyl *m*-nitrobenzoate, 601
— *sec.*Octyl *p*-nitrobenzoate, 601
$C_{15}H_{22}O$ Octylphenylketone, 478
$C_{15}H_{22}O_2$ Methylbenzylcarbinyl caproate, 482
— *sec.*Octyl benzoate, 485
$C_{15}H_{26}O_6$ Tributyrin, 444
$C_{15}H_{28}O_4$ Amyl glutarate, 452
— Butyl pimelate, 452
$C_{15}H_{29}N$ 2-Methylmyristonitrile, 542

$C_{15}H_{29}N$ 2-Methyltetradecanenitrile, 542
— Pentadecanenitrile, 541
$C_{15}H_{30}O_2$ *sec.*Butyl undecoate, 443
— Ethyl tridecoate, 443
— Heptyl caprylate, 442
— *sec.*Heptyl caprylate, 442
— *sec.*Hexyl nonoate, 443
— *sec.*Hexyl pelargonate, 443
— Methyl myristate, 443
— Nonyl caproate, 437
— *sec.*Nonyl caproate, 437
— Octyl oenanthate, 440
— *sec.*Octyl oenanthate, 440
— Pentadecanoic acid, 400
— Tridecyl acetate, 420
— *sec.*Tridecyl acetate, 420
— *sec.*Undecyl butyrate, 430
$C_{15}H_{32}$ Pentadecane, 112
$C_{15}H_{32}O$ Heptyl-*sec.*octyl ether, 350
$C_{15}H_{33}N$ Pentadecylamine, 524
— Tri*iso*amylamine, 524
— Triamylamine, 524
$C_{15}H_{33}O_4P$ Triamyl orthophosphate, 625

$C_{16}$

$C_{16}H_{10}$ Pyrene, 182
$C_{16}H_{12}O_2$ 1,2-Dibenzoylethylene, 479
$C_{16}H_{14}O_2$ 1,2-Dibenzoylethane, 479
$C_{16}H_{16}O_2$ Benzylmethylcarbinyl benzoate, 485
— Phenylbenzylcarbinyl acetate, 482
$C_{16}H_{24}O_2$ Methylbenzylcarbinyl oenanthate, 482
— *sec.*Nonyl benzoate, 485
— *sec.*Octyl *m*-toluate, 485
— *sec.*Octyl *o*-toluate, 485
— *sec.*Octyl *p*-toluate, 485
$C_{16}H_{24}O_3$ *sec.*Octyl *m*-methoxybenzoate, 486
— *sec.*Octyl *o*-methoxybenzoate, 486
— *sec.*Octyl *p*-methoxybenzoate, 486
$C_{16}H_{26}N_4O_7$ Diamylammonium picrate, 597
— Diethyldipropylammonium picrate, 597
— Methyltripropylammonium picrate, 597
$C_{16}H_{30}$ Hexadecyne-1, 140
$C_{16}H_{31}N$ Hexadecanenitrile, 541
— Palmitonitrile, 541
$C_{16}H_{32}O_2$ *sec.*Amyl undecoate, 443
— *sec.*Butyl laurate, 443
— Ethyl myristate, 443
— *sec.*Heptyl nonoate, 443
— *sec.*Heptyl pelargonate, 443
— Octyl caprylate, 442
$C_{16}H_{32}O_2$ *sec.*Octyl caprylate, 442
— Palmitic acid, 400
— *sec.*Undecyl valerate, 435
$C_{16}H_{34}$ Hexadecane, 112
$C_{16}H_{34}O$ Cetyl alcohol, 332
— Hexadecyl alcohol, 332
— Octyl-*sec.*octyl ether, 350
$C_{16}H_{35}N$ Hexadecylamine, 524

$C_{17}$

$C_{17}H_{20}O_2$ *sec.*Hexyl naphthoate, 486
$C_{17}H_{22}O$ Hexylnaphthylcarbinol, 458
$C_{17}H_{26}O_2$ Methylbenzylcarbinyl caprylate, 482
$C_{17}H_{28}N_4O_7$ Ethyltripropylammonium picrate, 597
$C_{17}H_{33}N$ Heptadecanenitrile, 541
— Margaronitrile, 541
$C_{17}H_{34}O_2$ *sec.*Amyl laurate, 443
— *sec.*Hexyl undecoate, 443
— Margaric acid, 401
— Methyl palmitate, 444
— *sec.*Octyl nonoate, 443
— *sec.*Octyl pelargonate, 443
— Undecyl caproate, 437
$C_{17}H_{36}$ Heptadecane, 113
$C_{17}H_{36}O$ Nonyl-*sec.*octyl ether, 350
$C_{17}H_{37}N$ Heptadecylamine, 524

$C_{18}$

$C_{18}H_{15}N$ Triphenylamine, 564
$C_{18}H_{15}As$ Triphenylarsine, 625
$C_{18}H_{15}Bi$ Triphenylbismuthine, 625
$C_{18}H_{15}P$ Triphenylphosphine, 625
$C_{18}H_{15}Sb$ Triphenylstibine, 625
$C_{18}H_{18}N_2O_5$ Ethyl *p*-azoxybenzoate, 590
$C_{18}H_{18}O_2$ Propyl phenylcinnamate, 485
$C_{18}H_{22}O_2$ *sec.*Heptyl naphthoate, 486
$C_{18}H_{28}O$ Undecylphenylketone, 478
$C_{18}H_{28}O_2$ Methylbenzylcarbinyl pelargonate, 482
— *sec.*Undecyl benzoate, 485
$C_{18}H_{30}$ Dodecylbenzene, 160
$C_{18}H_{30}N_4O_7$ Tetrapropylammonium picrate, 597
$C_{18}H_{34}$ Octadecyne-1, 140
$C_{18}H_{34}O_2$ Elaidic acid, 404
— Octadecen(17)oic acid, 404
— Oleic acid, 404
— Stearenic acid, 404
$C_{18}H_{34}O_3$ Ricinoleic acid, 405
$C_{18}H_{34}O_4$ *sec.*Octyl oxalate, 448
$C_{18}H_{35}N$ Octadecanenitrile, 541
— Stearonitrile, 541

$C_{18}H_{36}O$ Ethylpentadecylketone, 364
$C_{18}H_{36}O_2$ *sec.*Butyl myristate, 443
— Cetyl acetate, 421
— Dodecyl caproate, 437
— Ethyl palmitate, 444
— *sec.*Heptyl undecoate, 443
— *sec.* Hexyl laurate, 443
— *sec.*Nonyl nonoate, 443
— *sec.* Nonyl pelargonate, 443
— Stearic acid, 402
— *sec.*Undecyl oenanthate, 440
$C_{18}H_{38}$ Octadecane, 113
$C_{18}H_{39}N$ Octadecylamine, 524

$C_{19}$

$C_{19}H_{16}$ Triphenylmethane, 175
$C_{19}H_{16}O$ Triphenylcarbinol, 458
$C_{19}H_{24}O_2$ Naphthylhexylcarbinyl acetate, 482
— *sec.*Octyl naphthoate, 486
$C_{19}H_{30}O_2$ Methylbenzylcarbinyl decoate, 482
$C_{19}H_{36}O_2$ Methyl elaidate, 456
— Methyl oleate, 456
$C_{19}H_{38}O_2$ *sec.*Decyl nonoate, 443
— *sec.*Decyl pelargonate, 443
— *sec.*Heptyl laurate, 443
— *sec.*Octyl undecoate, 443
— Propyl palmitate, 444
— Tridecyl caproate, 437
$C_{19}H_{38}O_4$ Monopalmitin, 446

$C_{20}$

$C_{20}H_{16}$ Triphenylethylene, 177
$C_{20}H_{16}Cl_2O_8$ Methyl bis (chlorobenzoyl) tartrate, 516
$C_{20}H_{16}Br_2O_8$ Methyl bis(bromobenzoyl) tartrate, 516
$C_{20}H_{16}I_2O_8$ Methyl bis(iodobenzoyl)tartrate, 516
$C_{20}H_{18}$ 1,1,1-Triphenylethane, 176
— 1,1,2-Triphenylethane, 176
$C_{20}H_{18}O_2$ Benzylmethylcarbinyl naphthoate, 486
$C_{20}H_{18}O_8$ Dimethyl dibenzoyltartrate, 488
$C_{20}H_{26}O_2$ Naphthylhexylcarbinyl propionate, 482
— *sec.*Nonyl naphthoate, 486
$C_{20}H_{32}O$ Tridecylphenylketone, 478
$C_{20}H_{32}O_2$ Methylbenzylcarbinyl undecoate, 482
$C_{20}H_{34}$ Tetradecylbenzene, 160
$C_{20}H_{38}O_2$ Ethyl elaidate, 456
— Ethyl oleate, 456
$C_{20}H_{40}O_2$ Arachidic acid, 402
— *sec.*Butyl palmitate, 444
$C_{20}H_{40}O_2$ Ethyl stearate, 444
— *sec.*Hexyl myristate, 443
— *sec.*Nonyl undecoate, 443
— *sec.*Octyl laurate, 443
— Tetradecyl caproate, 437
— *sec.*Undecyl nonoate, 443
— *sec.*Undecyl pelargonate, 443
$C_{20}H_{42}$ Eicosane, 114

$C_{21}$

$C_{21}H_{21}N$ Tribenzylamine, 565
$C_{21}H_{28}O_2$ *sec.*Decyl naphthoate, 486
— Naphthylhexylcarbinyl butyrate, 482
$C_{21}H_{34}O_2$ Methylbenzylcarbinyl laurate, 482
$C_{21}H_{36}N_4O_7$ Triamylammonium picrate, 597
$C_{21}H_{38}O_6$ Tricaproin, 444
$C_{21}H_{40}O_2$ Propyl elaidate, 456
— Propyl oleate, 456
$C_{21}H_{42}O_2$ *sec.*Decyl undecoate, 443
— *sec.*Dodecyl nonoate, 443
— *sec.*Dodecyl pelargonate, 443
— *sec.*Heptyl myristate, 443
— *sec.*Nonyl laurate, 443
— Pentadecyl caproate, 437
— Propyl stearate, 444
$C_{21}H_{44}$ Heneicosane, 113

$C_{22}$

$C_{22}H_{22}O_8$ Diethyl dibenzoyltartrate, 488
$C_{22}H_{30}O_2$ Naphthylhexylcarbinyl valerate, 482
— *sec.*Undecyl naphtoate, 486
$C_{22}H_{34}O_2$ 1,2,3,4-Tetrahydro-2-naphthyllaurate, 498
$C_{22}H_{36}O_2$ Methylbenzylcarbinyl tridecoate, 482
$C_{22}H_{38}O$ Phenylcetyl ether, 471
$C_{22}H_{42}O_2$ Butyl elaidate, 456
— Butyl oleate, 456
— Erucic acid, 404
$C_{22}H_{44}O_2$ *sec.*Butyl stearate, 444
— *sec.*Decyl laurate, 443
— *sec.*Hexyl palmitate, 444
— *sec.*Octyl myristate, 443
— *sec.*Tridecyl nonoate, 443
— *sec.*Tridecyl pelargonate, 443
— *sec.* Undecyl undecoate, 443
$C_{22}H_{46}$ Docosane, 114

$C_{23}$

$C_{23}H_{32}O_2$ Naphthylhexylcarbinyl caproate, 482
$C_{23}H_{38}O_2$ Methylbenzylcarbinyl myristate, 482

$C_{23}H_{46}O$ Dilaurylketone, 360
$C_{23}H_{46}O_2$ *sec.*Dodecyl undecoate, 443
— *sec.*Heptyl palmitate, 444
— *sec.*Undecyl laurate, 443
$C_{23}H_{48}$ Tricosane, 113, 114

$C_{24}$

$C_{24}H_{34}O_2$ Naphthylhexylcarbinyl oenanthate, 482
$C_{24}H_{40}O_2$ Methylbenzylcarbinyl pentadecoate, 482
$C_{24}H_{48}$ 1-Cyclohexyloctadecane, 113
$C_{24}H_{48}O_2$ *sec.*Dodecyl laurate, 443
— *sec.*Hexyl stearate, 444
— *sec.*Octyl palmitate, 444
— *sec.*Tridecyl undecoate, 443
$C_{24}H_{50}$ 2,2-Dimethyldocosane, 113
— 2-Methyltricosane, 113
— Tetracosane, 113

$C_{25}$

$C_{25}H_{20}$ Tetraphenylmethane, 175
$C_{25}H_{36}O_2$ Naphthylhexylcarbinyl caprylate, 482
$C_{25}H_{42}O_2$ Methylbenzylcarbinyl palmitate, 482
$C_{25}H_{50}O_2$ *sec.*Heptyl stearate, 444
— *sec.*Tridecyl laurate, 443
— *sec.*Undecyl myristate, 443

$C_{26}$

$C_{26}H_{20}$ Tetraphenylethylene, 177
$C_{26}H_{22}$ 1,1,1,2-Tetraphenylethane, 176
— 1,1,2,2-Tetraphenylethane, 176
$C_{26}H_{38}O_2$ Naphthylhexylcarbinyl pelargonate, 482
$C_{26}H_{44}O_2$ Methylbenzylcarbinyl margarate, 482
$C_{26}H_{52}O_2$ *sec.*Octyl stearate, 444
$C_{26}H_{54}$ 13-Methylpentacosane, 113

$C_{27}$

$C_{27}H_{40}O_2$ Naphthylhexylcarbinyl decoate, 482
$C_{27}H_{46}O_2$ Methylbenzylcarbinyl stearate, 482
$C_{27}H_{50}O_6$ Tricaprylin, 444
$C_{27}H_{54}O_2$ *sec.*Undecyl palmitate, 444

$C_{28}$

$C_{28}H_{42}O_2$ Naphthylhexylcarbinyl undecoate, 482
$C_{28}H_{58}$ 10-Nonylnonadecane, 113
— Octacosane, 113

$C_{31}$

$C_{31}H_{62}O$ Dipalmitylketone, 360
$C_{31}H_{64}$ Hentriacontane, 113

$C_{32}$

$C_{32}H_{26}$ Pentaphenylethane, 176
$C_{32}H_{66}$ 7,12-Dimethyl-9,10-dihexyloctadecane, 113
— Dotriacontane, 114

$C_{33}$

$C_{33}H_{62}O_6$ Tricaprin, 444

$C_{34}$

$C_{34}H_{70}$ Tetratriacontane, 113

$C_{35}$

$C_{35}H_{72}$ Pentatriacontane, 113

$C_{36}$

$C_{36}H_{74}$ Hexatriacontane, 113

$C_{39}$

$C_{39}H_{74}O_6$ Trilaurin, 445

$C_{40}$

$C_{40}H_{82}$ Tetracontane, 113

$C_{43}$

$C_{43}H_{88}$ Tritetracontane, 113

$C_{44}$

$C_{44}H_{90}$ 22-Methyltritetracontane, 113

$C_{51}$

$C_{51}H_{98}O_6$ Tripalmitin, 446

# 2. SUBJECT INDEX

Unless otherwise indicated, all compounds in which the possibility of structural isomerism arises, are assumed to be the normal (*n*-) isomerides.


A

Acetaldehyde, 352
Acetamide, 583
Acetanilide, 589
Acetic acid, 380
Acetic anhydride, 375
Acetone, 353
Acetonitrile, 527
Acetophenone, 475
Acetyl chloride, 510
Acetylene, 138
Acetylene tetrabromide, 245
Acetylene tetrachloride, 244
2-Acetylthiophen, 624
Acrolein, 353
Acrylic acid, 404
Acrylic aldehyde, 353
Acrylonitrile, 542
Adipic acid, 404
Alanine, 587
Alanylglycine, 587
Alkylbenzenes, 173
Allylacetic acid, 404
Allyl alcohol, 333
Allyl chloride, 280
Allylene, 138
Allyl *iso*thiocyanate, 619
*m*-Aminobenzoic acid, 589
*o*-Aminobenzoic acid, 589
*p*-Aminobenzoic acid, 589
Amyl acetate, 419
Amyl alcohol, 325
*active* Amyl alcohol, 326
*iso*Amyl alcohol, 327
*sec.*Amyl alcohol, 328
*tert.*Amyl alcohol, 328
Amylbenzene, 161
*iso*Amyl bromide, 271
Amyl *iso*butyrate, 433
*sec.*Amyl butyrate, 430
Amyl caproate, 436
Amyl caprylate, 441
*iso*Amyl crotonate, 453
Amyl fluoride, 270
Amyl formate, 411
Amyl glutarate, 452
*sec.*Amyl laurate, 443
Amyl malonate, 452
Amyl-*sec.*octyl ether, 350
Amyl oenanthate, 439
Amyl oxalate, 452
Amyl pelargonate, 442
*sec.*Amyl pelargonate, 443
Amyl perfluoride, 272
*iso*Amyl perfluoride, 272
Amyl phenylketone, 478
Amyl propionates, 425
*sec.*Amyl propionate, 426
*sec.*Amyl undecoate, 443
*sec.*Amyl valerate, 435
Anabasine, 576
Anethole, 471
Angelic acid, 404
Aniline, 551
Aniline hydrochloride, 605
Anisole, 469
Anthracene, 181
Anthranilic acid, 589
Antipyrine, 589
Arachidic acid, 402
Arginine, 587
Azelaic acid, 404
*p*-Azoxyanisole, 590

B

Benzaldehyde, 474
Benzamide, 589
Benzene, 140, 628
Benzoic acid, 480
Benzonitrile, 566
Benzophenone, 478
*p*-Benzoquinone, 475
Benzotrichloride, 296
Benzotrifluoride, 295
Benzoylacetone, 479

Benzoyl chloride, 516
Benzyl alcohol, 457
Benzyl chloride, 295
Benzylideneacetone, 479
Benzylidenepinacoline, 479
Benzylmethylcarbinyl benzoate, 485
Benzylmethylcarbinyl naphthoate, 486
Bi*iso*amyl, 105
Bibenzyl, 176
Bi*iso*butyl, 89
Biphenyl, 174
Bi*iso*propyl, 52
Borneol, 497
*m*-Bromoaniline, 607
*o*-Bromoaniline, 607
*p*-Bromoaniline, 607
Bromobenzene, 286
Bromobenzylcyanide, 604
α-Bromocrotonamides, 604
α-Bromocrotonitrile, 603
4-Bromo-1,2-dinitrobenzene, 609
Bromoform, 221
2-Bromoheptane, 273
3-Bromoheptane, 273
4-Bromoheptane, 273
α-Bromonaphthalene, 300
*m*-Bromonitrobenzene, 609
2-Bromopentane, 272
*m*-Bromotoluene, 297
*o*-Bromotoluene, 297, 298
*p*-Bromotoluene, 297, 299
Butadiene-1,3, 135
Butane, 27
*iso*Butane, 29
Butene-1, 119
*cis*-Butene-2, 120
*iso*Butene, 123
*trans*-Butene-2, 122
Butyl acetate, 419
*sec.*Butyl acetate, 420
*sec.*Butylacetic acid, 394
*tert.*Butylacetic acid, 394
Butylacetylene, 140
Butyl alcohol, 318
*iso*Butyl alcohol, 320
*sec.*Butyl alcohol, 322
*tert.*Butyl alcohol, 324
Butylamine, 524
*iso*Butylammonium picrate, 597
Butylamylketone, 364
Butylbenzene, 159
*iso*Butylbenzene, 160
*sec.*Butylbenzene, 160
*tert.*Butylbenzene, 160
*iso*Butyl benzoate, 485
*sec.*Butyl benzoate, 485
*m*-Butylbenzoic acid, 481
*o*-Butylbenzoic acid, 481
*p*-Butylbenzoic-acid, 481
Butyl bromide, 265, 628
*iso*Butyl bromide, 266
*sec.*Butyl bromide, 267
*tert.*Butyl bromide, 268
Butyl butyrate, 429
*iso*Butyl butyrate, 429
*iso*Butyl *iso*butyrate, 433
*sec.*Butyl butyrate, 430
Butyl caproate, 436
*sec.*Butyl caproate, 437
Butyl caprylate, 441
*sec.*Butyl caprylate, 442
*iso*Butylcarbinol, 327
*sec.*Butylcarbinol, 326
Butyl chloride, 261
*iso*Butyl chloride, 262
*sec.*Butyl chloride, 263
*tert.*Butyl chloride, 264
Butyl crotonate, 453
*iso*Butyl crotonate, 453
*sec.*Butyl crotonate, 453
Butylcyclopentane, 190
Butyl elaidate, 456
Butyl fluoride, 261
*sec.*Butyl fluoride, 261
Butyl formate, 411
Butyl glutarate, 452
Butyl iodide, 268
*iso*Butyl iodide, 269
*sec.*Butyl iodide, 270
*iso*Butyl lactate, 452
*sec.*Butyl lactate, 452
*tert.*Butyl lactate, 452
*sec.*Butyl laurate, 443
*sec.*Butyl myristate, 443
*sec.*Butyl naphthoate, 486
Butyl-*sec.*octyl ether, 350
Butyl oenanthate, 439
*sec.*Butyl oenanthate, 440
Butyl oleate, 456
*sec.*Butyl palmitate, 444
Butyl pelargonate, 442
*sec.*Butyl pelargonate, 443
Butyl phenylchloroacetate, 516
Butylphenylketone, 478
Butyl pimelate, 452
Butyl propionates, 425
*iso*Butyl propionate, 425
*sec.*Butyl propionate, 426

*sec.*Butyl stearate, 444
*m-tert.*Butyltoluene, 173
*o-tert.*Butyltoluene, 173
*p-tert.*Butyltoluene, 173
*sec.*Butyl *n*-undecoate, 443
*sec.*Butyl *n*-valerate, 435
Butylvinylcarbinol, 334
Butyne-2, 139, 628
Butyramide, 584, 586, 587
Butyric acid, 386
*iso*Butyric acid, 388
Butyronitrile, 531
*iso*Butyronitrile, 532

C

Camphor, 497
Capric acid, 397
Caprinoyl chloride, 511
Caproic acid, 392
*iso*Caproic acid, 393
Caproic amide, 584, 586, 587
Caproic anhydride, 376
Capronitrile, 535
*iso*Capronitrile, 536
Caproyl chloride, 510
Caprylamide, 584, 586, 587
Caprylic acid, 396
Caprylonitrile, 537
Capryloyl chloride, 511
Carbamide, 583
Carbazole, 574
Carbon dioxide, 369
Carbon disulphide, 610
Carbon monoxide, 365
Carbon oxysulphide, 620
Carbon sesquisulphide, 614
Carbonsulphoselenide, 625
Carbon tetrabromide, 228
Carbon tetrachloride, 224, 628
Carbon tetrafluoride, 223
Carbonyl chloride, 506
Carvacrol, 466
Carvenone, 498
Carvone, 498
Cetyl acetate, 421
Cetyl alcohol, 332
α-Chloroacetonitrile, 603
Chloroacetophenone, 515
*o*-Chloroaniline, 607
Chlorobenzene, 282
*m*-Chlorobenzoic acid, 515
*o*-Chlorobenzoic acid, 515
*p*-Chlorobenzoic acid, 515
*m*-Chlorobenzoyl chloride, 516
*o*-Chlorobenzoyl chloride, 516
*p*-Chlorobenzoyl chloride, 516
α-Chlorobutyronitrile, 603
γ-Chlorobutyronitrile, 603
β-Chloro*iso*butyronitrile, 603
α-Chlorocapronitrile, 603
α-Chlorocaprylonitrile, 603
β-Chlorocrotonic acid, 510
β-Chloro*iso*crotonic acid, 510
γ-Chlorocrotonitrile, 603
α-Chlorodecanenitrile, 603
4-Chloro-1,2-dinitrobenzene, 609
2-Chloroethyl alcohol, 507
Chloroform, 218
2-Chloroheptane, 273
3-Chloroheptane, 273
4-Chloroheptane, 273
α-Chloroheptanenitrile, 603
β-Chloromethylacrylonitrile, 603
*m*-Chloronitrobenzene, 608
*o*-Chloronitrobenzene, 608
*p*-Chloronitrobenzene, 608
α-Chlorononanenitrile, 603
α-Chlorooctanenitrile, 603
α-Chlorooenanthonitrile, 603
α-Chloropelargonitrile, 603
2-Chloropentane, 272
Chloropicrin, 604
α-Chloropropionitrile, 603
*m*-Chlorotoluene, 297
*o*-Chlorotoluene, 297
*p*-Chlorotoluene, 297
2-Chloro-2,3,3-trimethylpentane, 275
α-Chloroundecanitrile, 603
α-Chlorovaleronitrile, 603
2-Chlorovinyldichloroarsine, 625
Citraconitrile, 547
Citrulline, 587
Creatine hydrate, 587
Creosol, 472
*m*-Cresol, 464
*o*-Cresol, 462
*p*-Cresol, 465
*m*-Cresyl acetate, 482
Crotonamide, 585, 586, 587
Crotonic acid, 404
Crotonitrile, 542
*iso*Crotonitrile, 543
*pseudo*Cumene, 170, 628
Cyanic acid, 588
Cyanogen, 547
Cyanogen chloride, 602
Cyanogen iodide, 602
Cyclohexadiene-1,3, 207

Cyclohexane, 193
Cyclohexanol, 491
Cyclohexanone, 493
Cyclohexene, 205
Cyclohexylamine, 568
Cyclohexyl cyanide, 568
Cyclohexylfluoroform, 301
Cyclohexyloctodecane, 113
Cyclohexyltrifluoromethane, 301
Cyclooctatetraene, 207
Cyclopentane, 184
Cyclopentanol, 489
Cyclopentanone, 490
Cyclopentene, 191
Cyclopentylamine, 567
Cyclopentyl bromide, 301
Cyclopentyl chloride, 301
Cyclopentyl cyanide, 568
Cyclopentyl fluoride, 301
Cyclopentylidene chloride, 301
Cyclopentyl iodide, 301
Cyclopropane, 183
Cysteine, 621
Cystine, 621

D

Decahydronaphthalene, 209
Decalin, 209
Decane, 103
Decaneamide, 584, 587
Decane dicarboxylic acid, 404
Decanenitrile, 539
Decanoyl chloride, 511
Decene(2)amide, 585, 587
Decyl acetate, 420
*sec.*Decyl acetate, 420
*tert.*Decyl alcohol, 332
Decyl alcohols, 332
Decylamine, 524
*sec.*Decyl laurate, 443
*sec.*Decyl naphthoate, 486
*sec.*Decyl pelargonate, 443
*sec.*Decyl undecoate, 443
Deuteromethane, 22
Di*iso*amyl, see Bi*iso*amyl
Diamylammonium picrate, 597
Diamyl ether, 348
Diamylketone, 360
Diamyl sulphate, 621
Diamyl sulphite, 621
Diazobenzeneimide, 567
1,2-Dibenzoylethane, 479
1,2-Dibenzoylethylene, 479
Dibenzyl, see Bibenzyl
Dibenzylamine, 565
1,1-Dibromoethane, 623
1,2-Dibromoethane, 239
*p*-Dibromobenzene, 294
1,2-Dibromopropane, 259
1,3-Dibromopropane, 259
1,5-Dibromopentane, 272
1,1-Dibutoxyethane, 352
Di*iso*butyl, see Bi*iso*butyl
Dibutyl acetal, 352
Dibutylamine, 524
Di*iso*butylcarbinol, 332
Dibutyl ether, 347
Dibutylketone, 358
Di*iso*butylketone, 359
Dibutyl sulphate, 621
Dibutyl sulphite, 621
*m*-Dichlorobenzene, 293
*o*-Dichlorobenzene, 292, 628
*p*-Dichlorobenzene, 292
1,1-Dichloro-1,2-dibromoethane, 246
$\beta,\beta'$-Dichlorodiethyl sulphide, 620
1,1-Dichloroethane, 238
1,2-Dichloroethane, 236
1,1-Dichloroethylene, 276
1,2-Dichloroethylene, 277
Dichloroethyl ether, 508
Dichloromonobromomethane, 223
1,1-Di-*p*-chlorophenyl-2,2,2-trichloroethane, 299
1,2-Dichloropropane, 256, 628
1,3-Dichloropropane, 258
2,2-Dichloropropane, 257
1,3-Dichloropropene, 280
2,6-Dichloroquinol, 515
2,6-Dichloroquinone, 515
1,1-Dichloro-1,2,2-tribromoethane, 246
Dicyclohexylamine, 568
1,1-Diethoxyethane, 628
Diethoxymethane, 351, 628
Diethylacetal, 628
Diethylacetic acid, 394
Diethylamine, 521
Diethylammonium picrate, 597
Diethylaniline, 557
Diethylbenzenes, 173
Diethylcarbinol, 329
Diethylcyclopentanol, 490
Diethyl dibenzoyltartrate, 488
Diethyldipropylammonium picrate, 597
Diethylene glycol dinitrate, 579
Diethyl ether, 341
Diethylformal, 351, 628
Diethylketone, 357

Diethyl monobenzoyltartrate, 488
3,3-Diethylpentane, 101
Diethyl phthalate, 486
Diethyl sulphate, 621
Diethyl sulphide, 618
Diethyl sulphite, 621
Difluoroacetic acid, 509
2,5-Difluoroaniline, 606
*m*-Difluorobenzene, 291
*p*-Difluorobenzene, 291
1,1-Difluoro-2-bromoethane, 243
1,1-Difluoro-2,2-dichloroethane, 246
Difluorodichloromethane, 230
*β,β*-Difluoroethyl acetate, 512
2,2-Difluoroethyl alcohol, 508
Difluoromonochloromethane, 222
1,2-Difluorotetrachloroethane, 249
Dihexylketone, 360
Dihydrocarvone, 498
Dihydroeucarvone, 498
*m*-Dihydroxybenzene, 468
*o*-Dihydroxybenzene, 467
*p*-Dihydroxybenzene, 468
1,2-Diiodoethylene, 278
Dilaurylketone, 360
*m*-Dimethoxybenzene, 472
*o*-Dimethoxybenzene, 471
*p*-Dimethoxybenzene, 472
1,1-Dimethoxyethane, 628
Dimethoxymethane, 350, 628
Dimethylacetal, 628
1,2-Dimethylacetylene, 139
Dimethylacrylic acid, 404
Dimethylamine, 520
Dimethylaniline, 555
Dimethylborofluoride, 627
2,2-Dimethylbutane, 56
2,3-Dimethylbutane, 52, 628
2,3-Dimethylbutanol-2, 331
2,3-Dimethylbutene-1, 130
3,3-Dimethylbutene-1, 130
2,3-Dimethylbutene-2, 131
1,1-Dimethylcyclohexane, 201
1,2-Dimethylcyclohexane, 201
1,3-Dimethylcyclohexane, 204
1,4-Dimethylcyclohexane, 204
1,2-Dimethylcyclohexanol-1, 492
1,3-Dimethylcyclohexanol-1, 492
1,4-Dimethylcyclohexanol-1, 492
1,4-Dimethylcyclohexene, 207
1,1-Dimethylcyclopentane, 191
1,2-Dimethylcyclopentane, 191
Dimethylcyclopentanol, 490
1,2-Dimethylcyclopentene, 192
1,5-Dimethylcyclopentene, 192
Dimethyl dibenzoyltartrate, 488
Dimethyldichlorosilane, 626
Dimethyldiethylmethane, 78
7,12-Dimethyl-9,10-dihexyloctadecane, 113
Dimethyldipropylammonium picrate, 597
2,2-Dimethyldocosane, 113
Dimethyl ether, 339
Dimethylethylacetic acid, 394
1,3-Dimethyl-4-ethylbenzene, 173
1,3-Dimethyl-5-ethylbenzene, 173
2,2-Dimethylbutyric acid, 394
2,3-Dimethylbutyric acid, 394
Dimethylethylcarbinol, 328
2,2-Dimethyl-3-ethylpentane, 101
2,4-Dimethyl-3-ethylpentane, 101
Dimethylformal, 350, 628
Dimethylglutaric acid, 404
2,5-Dimethylheptane, 99
2,6-Dimethylheptane, 100
2,3-Dimethylhexane, 89
2,4-Dimethylhexane, 89
2,5-Dimethylhexane, 89
3,3-Dimethylhexane, 89
3,4-Dimethylhexane, 89
Dimethyl monobenzoyltartrate, 488
2,7-Dimethyloctane, 105
2,2-Dimethylpentane, 72
2,3-Dimethylpentane, 74
2,4-Dimethylpentane, 76
3,3-Dimethylpentane, 78
2,2-Dimethylpropane, 40
1,1-Dimethylpropanol, 328
2,2-Dimethylpropionic acid, 392
2,4-Dimethyl-3-*iso*propylpentane, 107
Dimethyl sulphate, 621
Dimethyl sulphide, 616
Dimethyl sulphite, 621
Dimethyl-*o*-toluidine, 563
Dimethyl-*p*-toluidine, 563
*m*-Dinitrobenzene, 593
*o*-Dinitrobenzene, 593
*p*-Dinitrobenzene, 593
Dinitro-*o*-cresols, 600
1,5-Dinitronaphthalene, 597
1,8-Dinitronaphthalene, 597
2,4-Dinitrophenol, 599
2,5-Dinitrothiophen, 624
Dioxan, 502
Dipalmitylketone, 360
Diphenyl, see Biphenyl
1,2-Diphenylacetylene, 177
Diphenylamine, 563
Diphenylcyanoarsine, 625

1,1-Diphenylethane, 176
1,2-Diphenylethane, 176
1,2-Diphenylethylene, 176
Diphenylmethane, 174
Diphenyl ether, 473
Diphenylselenide, 625
Di*iso*propyl, see Bi*iso*propyl
Dipropylamine, 524
*m*Di*iso*propylbenzene, 173
*o*Di*iso*propylbenzene, 173
*p*Di*iso*propylbenzene, 173
Dipropyl ether, 346
Di*iso*propyl ether, 347, 628
Dipropylketone, 358
Di*iso*propylmethane, 76
Dipropyl sulphate, 621
Dipropyl sulphite, 621
$\beta,\beta'$-Dithiodilactic acid, 621
Divinyl ether, 350
Docosane, 114
Dodecane, 109
Dodecaneamide, 584
Dodecanenitrile, 540
Dodecyl acetate, 420
*tert.*Dodecyl alcohol, 332
Dodecylamine, 524
Dodecylbenzene, 160
Dodecyl caproate, 437
*sec.*Dodecyl laurate, 443
*sec.*Dodecyl pelargonate, 443
*sec.*Dodecyl undecoate, 443
Dotriacontane, 114
Durene, 172
*iso*Durene, 172

E

Eicosane, 114
Elaidic acid, 404
Epoxyethane, 499
Erucic acid, 404
Erythritol, 338
Ethane, 24
Ethane sulphonic acid, 621
Ethylacetanilide, 589
Ethyl acetate, 415
Ethyl adipate, 452
Ethylal, 351, 628
Ethyl alcohol, 306
Ethylamine, 519
Ethylammonium picrate, 597
Ethylamylketone, 364
Ethylaniline, 556
Ethyl azelate, 452
Ethyl *p*-azoxybenzoate, 590
Ethylbenzene, 154
Ethyl benzoate, 484
Ethyl bromide, 233
Ethyl bromoacetate, 514
Ethyl bromobutyrate, 514
Ethyl bromo*iso*butyrate, 514
Ethyl bromodipropylacetate, 514
Ethyl bromopropionate, 514
Ethylbutylketone, 364
Ethyl butyrate, 428
Ethyl *iso*butyrate, 432
2-Ethylbutyric acid, 394
Ethyl caprate, 443
Ethyl caproate, 436
Ethyl caprylate, 440
Ethyl carbamate, 589
Ethyl carbanilate, 589
Ethyl carbonate, 447
Ethylcarbylamine, 550
Ethyl chloride, 231
Ethyl chloroacetate, 513
$\alpha$-Ethyl-$\beta$-chlorobutyronitrile, 603
Ethyl cinnamate, 485
Ethyl crotonate, 453
Ethyl cyanide, 529
Ethyl *iso*cyanide, 550
Ethylcyclobutane, 183
Ethylcyclohexane, 201
Ethylcyclopentane, 187, 628
Ethyl dimethylsuccinate, 452
Ethyl dichloroacetate, 513
Ethyl dichlorosuccinate, 514
Ethyl difluoroacetate, 513
Ethylene, 115
Ethylene chlorohydrin, 507
Ethylene diacetin, 444
Ethylenediamine, 524
Ethylene dibromide, 239
Ethylene dichloride, 236
Ethylene dicyanide, 549
Ethylene glycol diacetate, 444
Ethyl elaidate, 456
Ethylene fluorohydrin, 508
Ethylene glycol, 334
Ethylene glycol dinitrate, 578
Ethylene oxide, 499
Ethyleugenol, 473
Ethyl fluoroacetate, 513
Ethyl fluoride, 231
Ethyl formate, 408
Ethyl fumarate, 455
Ethyl glutarate, 451
3-Ethylhexane, 89
Ethylidene dichloride, 238

Ethyl iodide, 235
Ethyl laurate, 443
Ethyl malate, 453
Ethyl malonate, 449
Ethyl mandelate, 486
Ethyl mercaptan, 615
Ethyl *o*-methoxybenzoate, 488
Ethyl methylsalicylate, 488
Ethyl myristate, 443
1-Ethylnaphthalene, 180
2-Ethylnaphthalene, 180
Ethylnaphthylcarbinol, 458
Ethyl nitrite, 578
Ethyl-*sec.*octyl ether, 350
Ethyl oenanthate, 438
Ethyl oleate, 456
Ethyl orthosilicate, 626
Ethyl oxalate, 448
Ethyl palmitate, 444
Ethyl pelargonate, 443
Ethylpentadecylketone, 364
3-Ethylpentane, 70
3-Ethylpentene-2, 134
Ethylphenylcarbinol, 458
Ethyl phenylchloroacetate, 516
Ethyl phenylglycolate, 486
Ethyl pimelate, 452
1-Ethylpropanol, 329
Ethyl propionate, 423
2-Ethyl-3-propylacrylic acid, 404
Ethylpropyl ether, 350
Ethylpropylketone, 364
Ethyl stearate, 444
Ethyl suberate, 452
Ethyl succinate, 450
Ethyl tartrate, 453
Ethyl *meso*tartrate, 453
Ethyl trichloroacetate, 513
Ethyl ω-trichlorobutyrate, 514
Ethyl tridecoate, 443
Ethyl trifluoroacetate, 513
Ethyl trimethylacetate, 435
Ethyltripropylammonium picrate, 597
Ethyl undecoate, 443
Ethyl valerate, 435
Ethylvinylcarbinol, 334
Eugenol, 472

F

Fenchyl alcohol, 496
*m*-Fluoroaniline, 605
*o*-Fluoroaniline, 605
*p*-Fluoroaniline, 605
Fluorobenzene, 281
β-Fluoroethyl acetate, 512
2-Fluoroethyl alcohol, 508
2-Fluorohexane, 272, 628
*m*-Fluoronitrobenzene, 607
*p*-Fluoronitrobenzene, 607
2-Fluoropentane, 272
*m*-Fluorophenetole, 514
*o*-Fluorophenetole, 514
*p*-Fluorophenetole, 514
*m*-Fluorophenol, 514
*o*-Fluorophenol, 514
*p*-Fluorophenol, 514
*m*-Fluorotoluene, 294
*o*-Fluorotoluene, 294
*p*-Fluorotoluene, 294
1-Fluoro-1,2,2-trichloroethane, 245
Formaldehyde, 352
Formamide, 582
Formanilide, 589
Formic acid, 377
Fumaric acid, 405
Furfural, 501

G

α-Galactose, 504
Gallic acid, 482
Glutamic acid hydrochloride, 604
Glutaric acid, 404
Glutaronitrile, 550
Glycerol, 336
Glyceryl trinitrate, 581
Glycols, 334
Glycylglycine, 587
Guanidine carbonate, 587

H

Hemimellitene, 171, 628
Heneicosane, 113
Hentriacontane, 113
1,1,1,2,2,3,3-Heptachloropropane, 260
Heptadecane, 113
Heptadecanenitrile, 541
Heptadecylamine, 524
Heptane, 60, 628
Heptanenitrile, 536
Heptanoic acid, 395
Heptanoyl chloride, 511
Heptene-1, 132
Heptene(2)amide, 585,586,587
Heptene(6)nitrile, 546
Hepten(6)oic acid, 404
Heptyl acetate, 420
*sec.*Heptyl acetate, 420
Heptyl alcohol, 331

Heptyl aldehyde, 353
Heptylamine, 524
Heptyl bromide, 274
Heptyl butyrate, 430
*sec.*Heptyl butyrate, 430
Heptyl caproate, 437
*sec.*Heptyl caproate, 437
Heptyl caprylate, 442
*sec.*Heptyl caprylate, 442
Heptyl chloride, 273
Heptyl fluoride, 273
Heptyl formate, 412
Heptyl iodide, 274
*sec.*Heptyl laurate, 443
*sec.*Heptyl myristate, 443
*sec.*Heptyl naphthoate, 486
Heptyl-*sec.*octyl ether, 350
Heptyl oenanthate, 440
*sec.*Heptyl oenanthate, 440
*sec.*Heptyl palmitate, 444
*sec.*Heptyl pelargonate, 443
Heptyl perfluoride, 273
Heptyl propionate, 426
*sec.*Heptyl propionate, 426
*sec.*Heptyl stearate, 444
*sec.*Heptyl undecoate, 443
Heptyl valerate, 434
*sec.*Heptyl valerate, 435
Heptyne-1, 140
Hexachlorobenzene, 294
Hexachloroethane, 248
Hexachlorocyclohexanes, 301
Hexadecane, 112
Hexadecanenitrile, 541
Hexadecyl alcohol, 332
Hexadecylamine, 524
Hexadecyne-1, 140
Hexamethylbenzene, 173
Hexamethylethane, 96, 628
Hexane, 41
Hexatriacontane, 113
Hexene-1, 129
Hexene(2)amide, 585, 586, 587
Hexene(5)nitrile, 545
Hexyl acetate, 420
*sec.*Hexyl acetate, 420
Hexyl alcohol, 330
Hexylamine, 524
Hexylbenzene, 161
*sec.*Hexyl benzoate, 485
Hexyl butyrate, 430
*sec.*Hexyl butyrate, 430
Hexyl caproate, 437
*sec.*Hexyl caproate, 437
Hexyl caprylate, 442
Hexyl fluoride, 272
*sec.*Hexyl fluoride, 272, 628
Hexyl formate, 412
Hexylic alcohols, 331
*sec.*Hexyl laurate, 443
*sec.*Hexyl myristate, 443
*sec.*Hexyl naphthoate, 486
Hexylnaphthylcarbinol, 548
Hexyl-*sec.*octyl ether, 350
Hexyl oenanthate, 440
*sec.*Hexyl oenanthate, 440
*sec.*Hexyl palmitate, 444
*sec.*Hexyl pelargonate, 443
Hexyl phenylketone, 478
Hexyl propionate, 426
*sec.*Hexyl propionate, 426
*sec.*Hexyl stearate, 444
*sec.*Hexyl undecoate, 443
Hexyl valerate, 434
*sec.*Hexyl valerate, 435
Hexyne-1, 140
Hippuric acid, 587
Hippurylglycine, 587
Hydrogen cyanide, 525
Hydroquinone, see Quinol
Hydroxyacetanilide, 589
*o*-Hydroxybenzoic acid, 481
Hydroxy*para*thymol methyl ether, 471

I

Iodobenzene, 289
Iodoform, 222
2-Iodopentane, 272
Isoprene, 137

L

β-Lactose, 505
α-Lactose monohydrate, 505
Lauric acid, 398
Lauronitrile, 540
Leucine, 587
Leucylglycine, 587

M

Maleic acid, 405
Maleic anhydride, 503
Malonic acid, 404
— substituted, 404
Malonitrile, 548
β-Maltose monohydrate, 505
Mannitol, 338
Margaric acid, 401
Margaronitrile, 541

Menthol, 495
Mesaconitrile, 547
Mesitylene, 170
Mesityloxide, 365
*iso*Mesityloxide, 365
Methane, 19
Methaneboronic acid, 627
Methaneboronic anhydride, 627
Methanesulphonic acid, 621
Methoxymethylenecamphor, 498
2-Methoxy-4-methylphenol, 472
*m*-Methoxyphenol, 472
*o*-Methoxyphenol, 472
*p*-Methoxyphenol, 472
Methylacetanilide, 589
Methyl acetate, 412
Methylacetylene, 138
Methylal, 350, 628
Methyl alcohol, 302
Methylamine, 517
Methylammonium chloride, 604
Methylamylketone, 364
Methylaniline, 554
Methyl azelate, 452
Methyl benzoate, 482
Methylbenzylcarbinol esters, 482
Methyl bis(bromobenzoyl)tartrate, 516
Methyl bis(chlorobenzoyl)tartrate, 516
Methyl bis(iodobenzoyl)tartrate, 516
Methylborodifluoride, 627
Methyl bromide, 213
Methyl bromopropionate, 514
2-Methylbutadiene-1,3, 137
2-Methylbutane, 36
1-Methylbutanol, 328
2-Methylbutanol, 326
2-Methylbutene-1, 127, 628
2-Methylbutene-2, 128
3-Methylbutene-1, 127, 628
Methylbutylketone, 362
Methyl butyrate, 426
Methyl *iso*butyrate, 430
2-Methylbutyric acid, 392
3-Methylbutyric acid, 391
2-Methylbutyronitrile, 541
Methyl caproate, 435
2-Methylcapronitrile, 541
Methyl caprylate, 442
2-Methylcaprylonitrile, 542
Methyl chloride, 211
Methylchloroform, 242
Methyl *allo*cinnamyl acrylate, 485
Methyl citraconate, 456
Methyl crotonate, 453
Methyl cyanide, 527
Methylcyclohexane, 197, 628
2-Methylcyclohexanone, 494
3-Methylcyclohexanone, 494
4-Methylcyclohexanone, 494
Methylcyclopentane, 187
1-Methylcyclopentanol-1, 489
Methylcyclopentanone ethyl carboxylate, 490
1-Methylcyclopentene, 192
Methylcyclopropane-1,1-dicarboxylate, 498
2-Methyldecanenitrile, 542
Methyldecylketone, 362
Methyldifluoromonochlorosilane, 626
Methyl dimethylmalonate, 452
Methyl dipropylmalonate, 452
3-Methyl-4,6-di*iso*propylphenol, 467
2-Methyldodecanenitrile, 542
Methyl elaidate, 456
Methylene dibromide, 216
Methylene dichloride, 215
Methylene dicyanide, 548
Methylene diiodide, 217
Methylethylacetic acid, 392
Methylethyl ether, 348
Methylethylketone, 360
Methyl ethylmalonate, 452
2-Methyl-3-ethylpentane, 95
2-Methyl-3-ethylpenten(3)oic acid, 404
Methyl ethylpropylmalonate, 452
Methylethyl*iso*propylmethane, 74
Methyleugenol, 473
Methyl*iso*eugenol, 473
Methyl fluoride, 210
Methylfluoroform, 240
Methyl formate, 406
Methyl fumarate, 454
Methylglutaric acid, 404
2-Methylheptane, 89
3-Methylheptane, 88
4-Methylheptane, 89
2-Methylheptanenitrile, 542
6-Methylheptene-1, 134
Methylheptylketone, 362
2-Methylhexane, 66
3-Methylhexane, 68
Methylhexylcarbinol, 331
Methylhexylketone, 362
Methyl iodide, 214
2-Methyllauronitrile, 542
Methyl malate, 453
Methyl maleate, 455
Methyl mandelate, 486
Methyl mercaptan, 614
Methyl mesaconate, 456

Methyl methylethylmalonate, 452
Methyl methylmalonate, 452
Methyl methylpropylmalonate, 452
Methylmonofluorodichlorosilane, 626
Methyl myristate, 443
2-Methylmyristonitrile, 542
1-Methylnaphthalene, 180
2-Methylnaphthalene, 180
Methylnaphthylcarbinol, 458
Methyl *o*-nitrobenzoyloxypropionate, 601
2-Methylnonane, 106
3-Methylnonane, 106
4-Methylnonane, 106
5-Methylnonane, 106
2-Methylnonanitrile, 542
Methylnonylketone, 362
2-Methyloctane, 99
3-Methyloctane, 99
4-Methyloctane, 99
2-Methyl octanenitrile, 542
Methyloctanols, 332
Methyl-*sec*.octyl ether, 350
Methyloctylketone, 362
Methyl oenanthate, 439
2-Methyloenanthonitrile, 542
Methyl oleate, 456
Methyl palmitate, 444
Methyl pelargonate, 442
2-Methylpelargonitrile, 542
13-Methylpentacosane, 113
2-Methylpentane, 47, 628
3-Methylpentane, 50
3-Methylpentanol-3, 331
3-Methylpentene-2, 129
4-Methylpenten-3-one-2, 365
4-Methylpenten-4-one-2, 365
Methyl 4-phenylbutadiene-1,3-carboxylate-1, 485
Methyl phenylglycolate, 486
1-Methyl-2-phenylhydrazine, 565
Methyl pimelate, 452
2-Methylpropane, 29
2-Methylpropene-1, 123
Methyl propionate, 421
Methylpropylacetic acid, 394
Methyl*iso*propylacetic acid, 394
1-Methyl-2-*iso*propylbenzene, 173
1-Methyl-3-*iso*propylbenzene, 173
Methylpropylcarbinol, 328
Methylpropylcyclopentanol, 490
Methylpropyl ether, 349
Methylpropylketone, 362
Methylpropylmalonate, 452
3-Methoxy-4-*iso*propyl-1-ethoxybenzene, 471
3-Methyl-4-*iso*propyl-1-methoxybenzene, 471
2-Methyl-5-*iso*propylphenol, 466
3-Methyl-4-*iso*propylphenol, 467
5-Methyl-2-*iso*propylphenol, 466
2-Methylpyridine, 570
2-Methylquinoline, 574
Methyl salicylate, 487
Methyl suberate, 452
Methyl succinate, 450
Methylsulphoxide, 621
Methyl tartrate, 453
Methyl *meso*tartrate, 453
2-Methyltetradecanenitrile, 542
5-Methyl-1,2,3,4-tetrahydronaphthalene, 208
6-Methyl-1,2,3,4-tetrahydronaphthalene, 208
2-Methylthiophen, 624
3-Methylthiophen, 624
Methyltrichlorosilane, 626
2-Methyltricosane, 113
Methyltrifluorosilane, 626
Methyltripropylammonium picrate, 597
22-Methyltritetracontane, 113
2-Methylundecanenitrile, 542
Methylundecylketone, 362
Methyl valerate, 435
2-Methylvaleric acid, 394
2-Methylvaleronitrile, 541
Methylvinylcarbinol, 334
Monobromoacetic acid, 510
Monobromoethylene, 276
Monochloroacetic acid, 509
Monochloroethylene, 276
Monochloroquinol, 515
Monochloroquinone, 515
Monodeuteromethane, 23
Monoethanolamine, 588
Monofluorodichloromethane, 222
Monofluorotrichloromethane, 229
Monoiodoacetic acid, 510
Monopalmitin, 446
Mustard gas, 620
Myristic acid, 399
Myristonitrile, 541

N

Naphthalene, 177
Naphthylhexylcarbinol esters, 482
Naphthylmethylcarbinyl acetate, 482
Nicotine, 575
*p*-Nitroaniline, 601
*p*-Nitroanisole, 601
Nitrobenzene, 591
*m*-Nitrobenzoic acid, 601
*p*-Nitrobenzoic acid, 601

*m*-Nitrochloroacetophenone, 609
*o*-Nitrochloroacetophenone, 609
Nitroglycerin, 581
Nitromethane, 577
α-Nitronaphthalene, 597
1-Nitropentane, 578
1-Nitro*iso*pentane, 578
*o*-Nitrophenol, 598
*p*-Nitrophenol, 599
2-Nitroresorcinol, 600
*p*-Nitrosomethylaniline, 597
2-Nitrothiophen, 624
*m*-Nitrotoluene, 595
*o*-Nitrotoluene, 594
*p*-Nitrotoluene, 596
Nonafluorocyclopentane, 301
Nonane, 97, 628
Nonane dicarboxylic acid, 404
Nonanenitrile, 538
Nonene(2)amide, 585, 586, 587
Nonoic acid, 397
Nonyl acetate, 420
*sec.*Nonyl acetate, 420
Nonyl alcohols, 332
*tert.*Nonyl alcohol, 332
Nonylamine, 524
*sec.*Nonyl benzoate, 485
Nonyl caproate, 437
*sec.*Nonyl caproate, 437
Nonoyl chloride, 511
*sec.*γ-Nonyl formate, 412
*sec.*Nonyl laurate, 443
*sec.*Nonyl naphthoate, 486
10-Nonylnonadecane, 113
Nonyl-*sec.*octyl ether, 350
*sec.*Nonyl pelargonate, 443
*sec.*Nonyl undecoate, 443

## O

Octacosane, 113
Octadecane, 113
Octadecanenitrile, 541
Octadecen(17)oic acid, 404
Octadecylamine, 524
Octadecyne-1, 140
Octane, 83
"*iso*Octane", see 2,2,4-Trimethylpentane
Octanenitrile, 537
Octene(2)amide, 585, 586, 587
Octene(7)nitrile, 546
Octenic acid, 404
Octoyl chloride, 511
Octyl acetate, 420
*sec.*Octyl acetate, 420
Octyl alcohol, 331
Octyl alcohols, 331
*sec.*Octyl alcohol, 331
*tert.*Octyl alcohol, 332
Octylamine, 524
*sec.*Octyl benzoate, 485
Octyl bromide, 275
β-Octyl bromoacetate, 513
Octyl bromobenzoate, 516
Octyl butyrate, 430
*sec.*Octyl butyrate, 430
Octyl caproate, 437
*sec.*Octyl caproate, 437
Octyl caprylate, 442
*sec.*Octyl caprylate, 442
β-Octyl chloroacetate, 513
Octyl chlorobenzoate, 516
Octyl fluoride, 275
Octyl formate, 412
*sec.*β-Octyl formate, 412
Octyl iodide, 275
β-Octyl iodoacetate, 513
Octyl iodobenzoate, 516
*sec.*Octyl laurate, 443
*sec.*Octyl methoxyacetate, 453
*sec.*Octyl *m*-methoxybenzoate, 486
*sec.*Octyl *o*-methoxybenzoate, 486
*sec.*Octyl *p*-methoxybenzoate, 486
*sec.*Octyl myristate, 443
*sec.*Octyl naphthoate, 486
*sec.*Octyl *m*-nitrobenzoate, 601
*sec.*Octyl *p*-nitrobenzoate, 601
Octyl-*sec.*octyl ether, 350
Octyl oenanthate, 440
*sec.*Octyl oenanthate, 440
*sec.*Octyl oxalate, 448
*sec.*Octyl palmitate, 444
*sec.*Octyl pelargonate, 443
Octylphenylketone, 478
Octyl propionate, 426
*sec.*Octyl propionate, 426
*sec.*Octyl stearate, 444
*sec.*Octyl *m*-toluate, 485
*sec.*Octyl *o*-toluate, 485
*sec.*Octyl *p*-toluate, 485
*sec.*Octyl undecoate, 443
Octyl valerate, 434
*sec.*Octyl valerate, 435
Oenanthal, 353
Oenanthamide, 584, 586, 587
Oenanthic acid, 395
Oenanthonitrile, 536
Oenanthoyl chloride, 511
Oleic acid, 404

Ornithine, 587
Ornithine dihydrochloride, 604
Oxalic acid, 403
Oxalonitrile, 547

P

Palmitic acid, 400
Palmitonitrile, 541
Paraldehyde, 500
Pelargonamide, 584, 587
Pelargonic acid, 397
Pelargonitrile, 538
Pelargoyl chloride, 511
Pentachlorobenzene, 293
Pentachloroethane, 247
Pentadecane, 112
Pentadecanenitrile, 541
Pentadecanoic acid, 400
Pentadecylamine, 524
Pentadecyl caproate, 437
Pentadiene-1,4, 136
Pentamethylbenzene, 172
Pentamethylene dibromide, 272
Pentamethylene dicyanide, 550
2,2,3,3,4-Pentamethylpentane, 107
2,2,3,4,4-Pentamethylpentane, 107
Pentane, 30
*iso*Pentane, 36
Pentaphenylethane, 176
Pentatriacontane, 113
Pentene-1, 124, 628
*cis*-Pentene-2, 125
*trans*-Pentene-2, 126
Pentene(2)amide, 585, 586, 587
Pentene(4)nitrile, 545
Penten(4)oic acid, 404
Perfluorocyclopentane, 301
Perfluoro-*m*-dimethylcyclohexane, 301
Perfluoro-*o*-dimethylcyclohexane, 301
Perfluoro-*p*-dimethylcyclohexane, 301
Perfluorodimethylcyclopentane, 301
Perfluoroethylcyclopentane, 301
Perfluoroheptane, 273
Perfluorohexahydroindane, 301
Perfluoromethylcyclohexane, 301
Perfluoropentane,272
Perfluoro*iso*pentane, 272
Perfluoro-1,3,5-trimethylcyclohexane, 301
Phenanthrene, 182
Phenazone, 589
Phenetole, 470
Phenol, 459
Phenylacetamide, 589
Phenylazoimide, 567
Phenylbenzylcarbinol, 458
Phenylbenzylcarbinyl acetate, 482
Phenylbutyl ether, 471
Phenylcetyl ether, 471
Phenylchloroform, 296
Phenylethylcarbinol, 458
Phenylfluoroform, 295
Phenylhydrazine, 565
Phenylmethylnitrosamine, 597
1-Phenyl-2-methylhydrazine, 565
5-Phenylpenten(3)oic acid, 481
Phenylpropylcarbinol, 458
Phenylpropyl ether, 471
Phenyl salicylate, 488
Phenyltrichloromethane, 296
Phenyltrifluoromethane, 295
N-Phenylurethan, 589
Phosgene, 506
Phosphorus containing compounds, 625
Phthalic acid, 482
α-Picoline, 570
Picrates of amines and ammonium bases, 597
Picric acid, 600
Pimelic acid, 404
Pimelonitrile, 550
α-Pinene, 209
β-Pinene, 209
Piperidine, 574
Prehnitene, 172
Proline, 587
Propane, 25
Propene, 117
*p*-Propenylanisole, 471
*iso*Propenylresorcinol dimethylether, 473
Propionamide, 583
Propionic acid, 383
Propionic anhydride, 376
Propionitrile, 529
Propionyl chloride, 510
Propyl acetate, 418
*iso*Propyl acetate, 419
*iso*Propylacetic acid, 391
Propyl alcohol, 313
*iso*Propyl alcohol, 316
Propylamine, 524
Propylbenzene, 157
*iso*Propylbenzene, 158
Propyl bromide, 252
*iso*Propyl bromide, 253
Propylbutylketone, 364
Propyl butyrate, 429
Propyl *iso*butyrate, 433
*iso*Propyl butyrate, 429
*iso*Propyl *iso*butyrate, 433

Propyl caproate, 436
Propyl caprylate, 441
Propyl chloride, 250
*iso*Propyl chloride, 251
Propyl crotonate, 453
*iso*Propyl crotonate, 453
Propyl cyanide, 531
*iso*Propyl cyanide, 532
*iso*Propylcyclohexane, 200
Propylcyclopentane, 190
Propyl elaidate, 456
Propylene dibromide, 259
Propylene dichloride, 256
Propylene glycol dinitrate, 580
3-Propyl-2-ethylacrylic acid, 404
*iso*Propylethylene, 127
Propyl formate, 410
Propyl glutarate, 452
*iso*Propylidene dichloride, 257
Propyl iodide, 254
*iso*Propyl iodide, 255
Propyl malonate, 452
Propyl mandelate, 486
1-*iso*Propylnaphthalene, 180
2-*iso*Propylnaphthalene, 180
Propyl nitrite, 578
Propyl-*sec.*octyl ether, 350
Propyl oenanthate, 439
Propyl oleate, 456
Propyl palmitate, 444
Propyl pelargonate, 442
Propyl phenylchloroacetate, 516
Propyl phenylcinnamate, 485
Propyl phenylglycolate, 486
Propyl pimelate, 452
Propyl propionate, 425
4-Propylpyrocatechol, 469
*iso*Propylresorcinol dimethylether, 473
Propyl stearate, 444
Propyl succinate, 451
*p*-*iso*Propylthymol, 467
Propyl valerate, 435
Propyl-vinylcarbinol, 334
Propyne, 138
Pulegone, 498
Pyrene, 182
Pyridine, 568
Pyrocatechol, 467

Q

Quinaldine, 574
Quinizarin, 479
Quinol, 468
Quinoline, 572
*iso*Quinoline, 571
Quinoxaline, 574

R

Resorcinol, 468
Ricinoleic acid, 405

S

Saccharose, 504
Safrole, 473
*iso*Safrole, 473
Salicylamide, 589
Salicylic acid, 481
Salol, 488
Sebacic acid, 404
Sorbose, 504
Stearenic acid, 404
Stearic acid, 402
Stearonitrile, 541
Stilbene, 176
Styrylethylketone, 479
Suberic acid, 404
Succinic acid, 403
— substituted, 404
Succinonitrile, 549
Succinoyl chloride, 511

T

Taurine, 621
Terephthalic acid, 482
Terpineol, 496
Terpineol esters, 496
1,1,2,2-Tetrabromoethane, 245
Tetrabromomethane, 228
1,2,3,4-Tetrachlorobenzene, 293
1,2,3,5-Tetrachlorobenzene, 293
1,2,4,5-Tetrachlorobenzene, 293
1,1,2,2-Tetrachloroethane, 244
Tetrachloroethylene, 278
Tetrachloromethane, 224, 628
Tetrachloroquinol, 515
Tetrachloroquinone, 515
Tetracontane, 113
Tetracosane, 113
Tetradecane, 111
Tetradecanenitrile, 541
*tert.*Tetradecyl alcohol, 332
Tetradecylamine, 524
Tetradecylbenzene, 160
Tetradecyl caproate, 437
Tetraethylbenzenes, 173
Tetraethylmethane, 101
Tetrafluoromethane, 223
1,2,3,4-Tetrahydronaphthalene, 208

1,2,3,4-Tetrahydro-2-naphthylacetate, 498
1,2,3,4-Tetrahydro-2-naphthyllaurate, 498
1,2,3,4-Tetrahydro-2-naphthylpropionate, 498
1,2,3,4-Tetrahydro-2-naphthylvalerate, 498
Tetrahydroquinoline, 574
Tetralin, 208
Tetramethylammonium iodide, 605
1,2,3,4-Tetramethylbenzene, 172
1,2,3,5-Tetramethylbenzene, 172
1,2,4,5-Tetramethylbenzene, 172
2,2,3,3-Tetramethylbutane, 96, 628
Tetramethylethylene, 131
2,2,3,3-Tetramethylhexane, 107
2,2,4,5-Tetramethylhexane, 107
2,2,5,5-Tetramethylhexane, 107
Tetramethylmethane, 40
Tetramethyl orthothiocarbonate, 618
2,2,3,3-Tetramethylpentane, 102
2,2,3,4-Tetramethylpentane, 102
2,2,4,4-Tetramethylpentane, 102
2,3,3,4-Tetramethylpentane, 102
2,2,4,4-Tetramethylpentanone-3, 365
Tetramethylsilane, 625
Tetranitromethane, 578
1,1,1,2-Tetraphenylethane, 176
1,1,2,2-Tetraphenylethane, 176
Tetraphenylethylene, 177
Tetraphenylmethane, 175
Tetrapropylammonium picrate, 597
Tetratriacontane, 113
Thiophen, 622
Thiophenol, 621
Thymol, 466
*p*-Thymol, 467
*p*-Thymol ethyl ether, 471
Tiglic acid, 404
Toluene, 150, 628
*m*-Toluidine, 560
*o*-Toluidine, 558
*p*-Toluidine, 561
Trialkylchloromethanes, 275
Triamylamine, 524
Tri*iso*amylamine, 524
Triamylammonium picrate, 597
Triamyl orthophosphate, 625
Tribenzylamine, 565
1,1,2-Tribromoethane, 628
Tribromomethane, 221
Tributylamine, 524
Tributyl orthophosphate, 625
Tributyrin, 444
Tricaprin, 444
Tricaproin, 444
Tricaprylin, 444
1,2,3-Trichlorobenzene, 293, 294
1,2,4-Trichlorobenzene, 293, 294
1,3,5-Trichlorobenzene, 293, 294
1,1,1-Trichloroethane, 242
1,1,2-Trichloroethane, 241
Trichloromethane, 218
Trichloronitromethane, 604
1,2,3-Trichloropropane, 260
Trichloroquinol, 515
Trichloroquinone, 515
Tricosane, 113, 114
Tridecane, 110
Tridecanenitrile, 540
Tridecanoic acid, 399
Tridecyl acetate, 420
*sec.*Tridecyl acetate, 420
*tert.*Tridecyl alcohol, 332
Tridecylamine, 524
Tridecyl caproate, 437
*sec.*Tridecyl laurate, 443
*sec.*Tridecyl pelargonate, 443
Tridecylphenylketone, 478
*sec.*Tridecyl undecoate, 443
Triethylamine, 523
Triethylammonium picrate, 597
Triethyl borate, 627
Triethylmethane, 70
Triethyl orthophosphate, 625
Triethylphosphine, 625
Trifluoroacetic acid, 509
3,3,3-Trifluoro*iso*butyl alcohol, 508
1,1,1-Trifluoroethane, 240
2,2,2-Trifluoroethyl acetate, 512
2,2,2-Trifluoroethyl alcohol, 508
2,2,2-Trifluoroethyl trifluoroacetate, 513
Trifluoromethylcyclohexane, 301
Trifluoromonochloroethylene, 279
2,2,2-Trifluoro*iso*propyl acetate, 512
2,2,2-Trifluoro*iso*propyl alcohol, 508
1,1,2-Trifluoro-1,2,2-trichloroethane, 249
Triiodomethane, 222
Trilaurin, 445
Trimethylacetic acid, 392
Trimethylacrylic acid, 404
Trimethylamine, 522
1,2,3-Trimethylbenzene, 171, 628
1,2,4-Trimethylbenzene, 170, 628
1,3,5-Trimethylbenzene, 170
Trimethyl borate, 627
2,2,3-Trimethylbutane, 80
2,3,3-Trimethylbutene-1, 133
Trimethylcarbinol, 324
Trimethylene dibromide, 259

Trimethylene dichloride, 258
Trimethylene dicyanide, 550
Trimethylene glycol dinitrate, 580
Trimethylethylmethane, 56
2,2,4-Trimethylhexane, 101
2,2,5-Trimethylhexane, 101
2,3,5-Trimethylhexane, 101
Trimethyl orthophosphate, 625
2,2,3-Trimethylpentane, 91
2,2,4-Trimethylpentane, 92
2,3,3-Trimethylpentane, 95
2,3,4-Trimethylpentane, 95
2,2,4-Trimethylpentanone-3, 365
Trimethyl*iso*propylmethane, 80
1,3,8-Trinitronaphthalene, 597
1,4,5-Trinitronaphthalene, 597
2,4,6-Trinitrophenol, 600
2,4,6-Trinitrotoluene, 597
Tripalmitin, 446
Triphenylamine, 564
Triphenylarsine, 625
Triphenylbismuthine, 625
Triphenylcarbinol, 458
1,1,1-Triphenylethane, 176
1,1,2-Triphenylethane, 176
Triphenylethylene, 177
Triphenylmethane, 175
Triphenylphosphine, 625
Triphenylstibine, 625
Tripropyl orthophosphate, 625
Tritetracontane, 113
Tyrosine, 587

U

Undecafluoro*iso*pentane, 272
Undecafluoropentane, 272
Undecane, 107
Undecaneamide, 584, 587
Undecane dicarboxylic acid, 404
Undecanenitrile, 540
Undecanoic acid, 398
Undecene(2)amide, 585, 587
Undecen(10)oic acid, 404
Undecyl acetate, 420
*sec.*Undecyl acetate, 420
*tert.*Undecyl alcohol, 332
Undecylamine, 524
*sec.*Undecyl benzoate, 485
*sec.*Undecyl butyrate, 430
Undecyl caproate, 437
*sec.*Undecyl laurate, 443
*sec.*Undecyl myristate, 443
*sec.*Undecyl naphthoate, 486
*sec.*Undecyl oenanthate, 440
*sec.*Undecyl palmitate, 444
*sec.*Undecyl pelargonate, 443
Undecyl phenylketone, 478
*sec.*Undecyl propionate, 426
*sec.*Undecyl undecoate, 443
*sec.*Undecyl valerate, 435
Undecyne-1, 140
Urea, 583
Urethan, 589

V

Valeramide, 584, 586, 587
Valeric acid, 390
*iso*Valeric acid, 391
Valeronitrile, 533
*iso*Valeronitrile, 534
Veratrole, 471
Vinyl acetate, 421
Vinylacetonitrile, 544
Vinyl bromide, 276
Vinyl chloride, 276
Vinylidene chloride, 276

X

*m*-Xylene, 164
*o*-Xylene, 161
*p*-Xylene, 166
*m*-Xylidine, 563
*p*-Xyloquinol, 469
*p*-Xyloquinone, 475

Y

Yperite, 620